R 6000-3.13-

COMMITTEE ON
POPULATION AND DEMOGRAPHY

Report No. 21

Levels and Recent Trends in Fertility and Mortality in Brazil

Panel on Brazil

Committee on Population and Demography
Commission on Behavioral and
Social Sciences and Education
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1983

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

Available from

NATIONAL ACADEMY PRESS
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Printed in the United States of America

PANEL ON BRAZIL

CARMEN ARRETX, Centro Latinamericano de Demografia (CELADE), Santiago, Chile
WILLIAM BRASS, London School of Hygiene and Tropical Medicine
JOSE ALBERTO MAGNO de CARVALHO, CEDEPLAR-UFMG, Brazil
VALERIA da MOTTA LEITE, Fundacao IBGE, Rio de Janeiro
THOMAS W. MERRICK, Center for Population Research, Georgetown University
AXEL I. MUNDIGO, Mexico City, Mexico

ROBERT J. LAPHAM, Study Director

COMMITTEE ON POPULATION AND DEMOGRAPHY

ANSLEY J. COALE (Chair), Office of Population Research, Princeton University
WILLIAM BRASS, Centre for Population Studies, London School of Hygiene and Tropical Medicine
LEE-JAY CHO, East-West Population Institute, East-West Center, Honolulu
RONALD FREEDMAN, Population Studies Center, University of Michigan
NATHAN KEYFITZ, Department of Sociology, Harvard University
LESLIE KISH, Institute for Social Research, University of Michigan
W. PARKER MAULDIN, Population Division, The Rockefeller Foundation, New York
JANE MENKEN, Office of Population Research, Princeton University
SAMUEL PRESTON, Population Studies Center, University of Pennsylvania
WILLIAM SELTZER, Statistical Office, United Nations
CONRAD TAEUBER, Kennedy Institute, Center for Population Research, Georgetown University
ETIENNE VAN DE WALLE, Population Studies Center, University of Pennsylvania

ROBERT J. LAPHAM, Study Director

NOTE: Members of the Committee and its panels and working groups participated in this project in their individual capacities; the listing of their organizational affiliation is for identification purposes only, and the views and designations used in this report are not necessarily those of the organizations mentioned.

CONTENTS

LIST OF TABLES vii
LIST OF FIGURES x
PREFACE xiii
SUMMARY 1

1 INTRODUCTION 8

- Brazil: Its Place in the World, 8
- Brazil: Its Geography, 10
- Data Sources, 12
  - Censuses, 13
  - Vital Registration, 18
  - Sample Surveys, 18
    - Description of the PNAD Sample, 21
    - Expansion of the PNAD Results, 23
    - Some Aspects of the PNAD Field Work, 24
- Organization of the Report, 25

2 MORTALITY 26

- Estimating Childhood Mortality, 26
  - Sources and Type of Data, 26
  - Correction of the Data on Children Ever Born for 1950 and 1960, 29
  - Comparison and Assessment of the Child Mortality Estimates, 32
  - A Final Set of Child Mortality Estimates, 53
- Estimating Adult Mortality, 55
  - The Preston Method of Intercensal Comparisons, 60
  - Stable and Quasi-Stable Analyses, 66
  - Methods Based on the Age Distribution of Deaths, 72
    - Estimates for 1960, 72
    - Estimates for 1975, 78

Estimates Based on Information on Maternal Orphanhood, 83
Comparison and Assessment of the Adult Mortality Estimates, 86
A Final Set of Mortality Estimates for Brazil and Its Regions, 89
Conclusion, 92

3 FERTILITY 94

Estimating Fertility, 94
The Brass Estimation Procedure, 96
The 1950 and 1960 Censuses, 97
The 1970 Census and the PNAD Surveys, 110
The Selection of Adjustment Factors for Age-Specific Fertility During the 1950-77 Period, 114
The Own-Children Method, 118
Own-Children Estimates for Brazil as a Whole, 133
Regional Own-Children Estimates, 134
A Revised Set of Fertility Estimates for Brazil as a Whole, 135
A Revised Set of Total Fertility Estimates for Brazil as a Whole, 137
A Revised Series of Age-Specific Fertility Estimates for Brazil as a Whole, 140
Conclusion, 149

4 POPULATION GROWTH 150

Components of Growth, 150
Age Distribution of the Population, 155

APPENDIX 161

REFERENCES 167

GLOSSARY 171

LIST OF TABLES

1 Summary of Estimated Mortality Measures, 1940-75 3
2 Summary of Final Fertility Estimates, 1940-78 5
3 Definition of Brazil's Regions 11
4 Enumerated Population by Sex and Residence According to Different Censuses, 1940-80 14
5 Average Annual Growth Rates by Sex for Different Intercensal Periods, 1940-80 15
6 Information Collected by Each Census, 1940-70 16
7 Information Collected by Each of the PNAD Surveys 20
8 Percentage of Children Born Dead Among Those Ever Born by Age of Mother, 1940 and 1970 28
9 Estimated Regression Coefficients Defining the Linear Relationship Between CS/CEB and CS/(CEB+CBD), and Measures of the Goodness of Fit of this Model 30
10 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1950 Census Data 33
11 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1960 Census Data 34
12 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1970 Census Data 35
13 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1972 PNAD Data 36
14 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1973 PNAD Data 37
15 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1974-75 ENDEF Data 38
16 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1976 PNAD Data 39

17 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1977 PNAD Data 40
18 Regional Distribution of the Population, 1960 and 1970 42
19 Set of Key Child Mortality Levels 54
20 Final Child Mortality Estimates, 1940-75 56
21 Intercensal Estimates of Adult Mortality, 1940-70 61
22 Observed and Adjusted Intercensal Growth Rates, 1940-70 65
23 Intercensal Estimates of Adult Mortality Derived from Adjusted Data, 1940-60 67
24 Adjusted Growth Rates (in percent) for Exact Dates, 1940-70 68
25 Observed Proportions Under Age x for 1940 and Adult Mortality Estimates Derived by Fitting Stable Populations to the Observed Proportions Under Age x 69
26 Observed Proportions Under Age x, Adult Mortality Estimates Derived by Fitting Quasi-Stable Populations to the Observed Proportions Under Age x and Birth-Rate Equivalents, 1950 and 1960 70
27 Estimates of Death Registration Completeness for Different Truncation Ages by Sex, 1960 73
28 Adjusted Age-Specific Mortality Rates and Corresponding West Mortality Levels by Sex, 1960 77
29 Application of the Growth Balance Equation Method by Sex, 1960 78
30 Estimated Population and Registered Deaths by Sex and Age, 1975 79
31 Estimates of Death Registration Completeness for Different Truncation Ages by Sex, 1975 81
32 Adjusted Age-Specific Mortality Rates and Corresponding West Mortality Levels by Sex, 1975 83
33 Estimation of Female Adult Mortality on the Basis of Data on Maternal Orphanhood 84
34 Regional Differentials in Female Adult Mortality as Estimated from Data on Maternal Orphanhood 86
35 Selected Estimates of Adult Mortality by Sex in Terms of West Mortality Levels, 1940-75 88
36 Final Estimates of Adult Mortality in Terms of West Mortality Levels and Estimated Values of e_0 and e_5 by Sex, 1940-75 89
37 Reported Parities for Brazil and its Regions, 1950-77 98
38 Age-Specific Fertility Rates Adjusted for Half-a-Year Age Shift, 1950-77 102

39 Estimated P/F Ratios for Brazil and its Regions, 1950-77 106
40 Age-Specific Fertility Schedules Adjusted by the Mean of the P/F Ratios Corresponding to Age Groups 20-24, 25-29, and 30-34, 1950-77 115
41 Own-Children Estimates of Fertility by Three-Year Periods Derived from the 1960 Census 120
42 Own-Children Estimates of Fertility by Three-Year Periods Derived from the 1970 Census 122
43 Own-Children Estimates of Fertility by Three-Year Periods Derived from the 1976 PNAD 124
44 Derivation of Revised Total Fertility Estimated for the Whole Country, 1945-76 138
45 Estimation of Intersurvey Fertility, 1972(73)-77 140
46 Selected Set of Total Fertility Estimates for the Country as a Whole, 1940-77 141
47 Selected Set of Fertility Density Functions for the Country as a Whole 145
48 Final Set of Estimated Age-Specific Fertility Schedules for the Country as a Whole, 1940-80 148
49 Estimated Quinquennial Birth Rates, Death Rates, and Rates of Natural Increase by Sex, 1940-80 152
50 Estimated Population at the Time of the Censuses and Estimated Completeness of Enumeration, 1940-80 153
51 Estimated Intercensal Rates of Natural Increase, 1940-80 154
52 Estimated Age Distributions at the Time of the Censuses, 1940-80 156

LIST OF FIGURES

1 Estimated Rates of Natural Increase, 1940-80 6
2 Brazil and its Seven Main Regions 9
3 Linear Relationship Between Two Ratio Measures of Child Mortality: Children Surviving of Children Ever Born (CS/CEB) and Children Surviving of Children Born Alive and Children Born Dead (CS/CEB + CBD), 1976 Census 31
4 Estimates of $_2q_0$ for the Country as a Whole 44
5 Estimates of $_2q_0$ for Region 1 45
6 Estimates of $_2q_0$ for Region 2 46
7 Estimates of $_2q_0$ for Region 3 47
8 Estimates of $_2q_0$ for Region 4 48
9 Estimates of $_2q_0$ for Region 5 49
10 Estimates of $_2q_0$ for Region 6 50
11 Estimates of $_2q_0$ for Region 7 51
12 Estimated Levels of Adult Mortality Compared, 1940-65, Females 62
13 Estimated Levels of Adult Mortality Compared, 1940-65, Males 63
14 Estimates of the Completeness of Death Registration in 1960 Relative to the 1960 Census Count 75
15 Estimates of the Completeness of Death Registration in 1975 Relative to the 1976 Listagem 82
16 Selected Estimates of Adult Mortality, 1940-75 89
17 Comparison of Total Fertility Estimates, 1946-77, Brazil 126
18 Comparison of Total Fertility Estimates, 1946-77, Region 1 127
19 Comparison of Total Fertility Estimates, 1946-77, Region 2 128
20 Comparison of Total Fertility Estimates, 1946-77, Region 3 129
21 Comparison of Total Fertility Estimates, 1946-77, Region 4 130

22 Comparison of Total Fertility Estimates, 1946-77, Region 5 131
23 Comparison of Total Fertility Estimates, 1946-77, Region 7 132
24 Comparison of Fertility Density Functions from Different Sources 142
25 Graphic Comparison of the Selected Set of Fertility Density Functions 146
26 Graphic Comparison of the Fitted Set of Fertility Density Functions 147
27 Comparison of the Observed and Estimated Age Distributions, 1940-70 157

PREFACE

The Committee on Population and Demography was established in April 1977 by the National Research Council in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, and about the existence and extent of recent changes in fertility.

In 1963, a Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less-developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Commission on Behavioral and Social Sciences and Education of the National Research Council. It was funded for a period of five and one-half years by AID under Contract No. AID/pha-C-1161 and Grant No. AID/DSPE-G-0061. The committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;
2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);
3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

The committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of the most reliable methods known, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Estimates of levels and recent trends judged to be the best are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The committee set three criteria for identifying countries to study in detail: that the country have a population large enough to be important in a world view; that there be some uncertainty about levels and recent trends of fertility or mortality; and that sufficient demographic data be available to warrant a detailed study. After a country has been selected for detailed study, the usual procedure is to set up a panel or working group of experts, both nationals of the country and others knowledgeable about the demography and demographic statistics of the country. The role of these panels and working groups, which generally include at least one committee member, is to carry out the comparisons and analyses required. A small staff assists the committee, panels, and working groups in their work. In a few cases, including the Brazil study, a staff member has undertaken primary responsibility for analyzing available data and preparing the report.

A total of some 170 population specialists, including 94 from developing countries, have been involved in the work of the committee as members of panels or working groups. The committee, the commission, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

Each country being studied has a different mix of data sources and different problems with data errors. Therefore, there is no standard pattern for all the reports. However, each report includes a summary of the main findings regarding estimates of fertility and mortality, a description of the data sources available, and a presentation of the analyses that were carried out, classified by type of data analyzed; detailed methodological descriptions are included where necessary in appendixes.

In some of the reports the estimates of fertility and mortality are presented as ranges. The use of a range is deliberate. It indicates that the panel and the committee are confident that the range includes the true value, but have concluded that the evidence does not warrant selecting a single figure as best. The range conveys an important aspect (uncertainty) of the estimation. Ideally, in constructing an average for several populations in each of which estimation is presented as a range, an aggregate range would be calculated (as the population-weighted average of the constituents). The user who selects a single figure from the middle of the range does so at the risk of misleading simplification.

This report, on levels and recent trends of fertility and mortality in Brazil, is No. 21 in a series of reports issued by the Committee on Population and Demography. The Panel on Brazil was organized in 1978. Following two panel meetings, in 1978 and early 1979, a draft report was prepared by Hania Zlotnik, a research associate on the committee staff, who used ideas and working documents provided by panel members. That draft report was extensively discussed at a workshop held in Brazil in May 1979, co-sponsored by the panel, the Associacao Brasileira de Estudos Populacionais (ABEP), and the Instituto Brasileiro de Geografia e Estatistica (IBGE). The Ford Foundation provided financial assistance for the workshop, which was attended by about 25 experts and officials concerned with demographic measurement in Brazil in addition to the panel members and two committee members.

Following the workshop, Hania Zlotnik extensively revised and updated the manuscript, drawing on the contributions and guidance provided at the workshop and subsequent contributions from panel and committee members. The committee's thanks are particularly heartfelt because Dr. Zlotnik voluntarily continued to work on and complete the report after she left the committee staff at the end of 1981 to take up new responsibilities at the United Nations Population Division.

The committee is grateful to the IBGE for making possible the use of data from several censuses and national household surveys conducted in Brazil. Also, special thanks are due to Maria Helena Henriques and to Jose Alberto M. de Carvalho for their help in organizing the workshop; at that time they were, respectively, vice president and president of ABEP.

The committee also wishes to thank several other people who contributed in various ways. Katherine Miller Malin, edited the report, and Solveig Padilla and Irene Martinez assisted with typing the text and many tables. In addition to panel, committee, and commission reviews, Eduardo Arriaga provided a review of the report for the commission. Ken Hill, a member of the committee staff, provided helpful comments at various stages of the work, and Jane Durch, research assistant with the committee 1980-1981, helped with the computer analyses. The figures were kindly drawn by Susan Lapham, now senior cartographer at Geosciences Research Associates, Inc. Finally, Elaine McGarraugh prepared the manuscript for publication. For the contributions of all of these individuals, the committee extends its warm appreciation.

ANSLEY J. COALE, Chair
Committee on Population and Demography

SUMMARY

Brazil is the largest Latin American country in terms of both area and population size. Its population, approximately 119 million at latest count (1980), is distributed unevenly over its vast territory, concentrated mostly in the states bordering the Pacific Ocean and in the central region, still far removed from the Amazonian jungle. The diversity of geographic regions inhabited by the Brazilian population traditionally has been associated with an equally varied set of patterns of population growth. Thus, for example, while the country's most prosperous regions, Rio de Janeiro and Sao Paulo, have been characterized by relatively low fertility and mortality levels, not dissimilar to those observed in the wealthier countries of the region (such as Argentina and Chile), the Northeast still exhibits relatively high fertility and unacceptably high child mortality. Given the great regional diversity known to characterize the Brazilian population, this report investigates regional differences in both fertility and mortality and uses them as a basis for deriving estimates at the country level.

During the past decade Brazil has undergone at least two changes of great importance from a demographic perspective. First, the fertility decline that had already begun by the time of the 1970 census has continued at what appears to be an ever increasing pace. Second, official interest in the components of population growth and in their regional variations spurred the establishment of a household survey program which completed at least six nationwide surveys during the 1970-79 decade, all of which explored demographic characteristics of the population, among other topics. Thus, there is no lack of demographic information for that period, a fact that has greatly helped to further our knowledge and understanding of Brazil's demographic trends.

In contrast, little demographic information is available for years prior to 1970. One has to rely mainly on the results of the decennial censuses, since vital statistics are almost nonexistent (they were poorly maintained and published only infrequently during the period) and the sample survey had not yet been used as a data-gathering tool at the national level. In spite of these shortcomings, the retrospective nature of the data gathered at later points in time has made it possible to derive fairly reliable estimates for approximately the 1960-75 period. Those for earlier or later periods are usually based on weaker and less abundant data and should therefore be interpreted with caution.

Chapter 1 provides a detailed description of the sources of demographic data used in this report, while Chapters 2 and 3 describe the analytical methods applied in deriving estimates of mortality and fertility, respectively. Tables 1 and 2 summarize some of the final mortality and fertility estimates produced; Figure 1 presents the final estimated rates of natural increase.

CHILD MORTALITY

Table 1 presents the national estimates of infant and child mortality obtained for the 1940-75 period. According to these estimates, infant mortality in the country as a whole declined by about 40 percent beween 1940 and 1975, from 142 infant deaths per 1,000 live births to 86 deaths per 1,000. Child mortality appears to have undergone a somewhat greater reduction, about 50 percent. The estimated probability of dying between birth and exact age 5 was 118 deaths per 1,000 in 1970, as compared with 233 deaths per 1,000 in 1940.

Regional estimates of infant and child mortality (shown in Table 20) reveal the existence of significant regional differentials. It appears that by 1975 the southeastern part of the country (Rio de Janeiro, Sao Paulo, and the southern region bordering Uruguay) was experiencing fairly low levels of infant ($_1q_0$) and child mortality ($_5q_0$): about 67-70 and 85-90 deaths per 1,000 births, respectively. The Northeast, on the other hand, displayed infant and child mortality rates that were almost twice as high: 125 and 197 deaths per 1,000. In addition, although the direction of such differentials was maintained between 1940 and 1975, their relative magnitude increased substantially. Thus, while

P

TABLE 1 Summary of Estimated Mortality Measures, 1940-75: Brazil

				Adult Mortality			
	Infant and Child Mortality			Male		Female	
Year	$_1q_0$	$_5q_0$	$_{10}q_0$	e_0	e_5	e_0	e_5
1940	.142	.233	.251	44.50	53.18	47.01	55.41
1945	.136	.220	.237	46.01	54.18	48.56	56.44
1950	.130	.208	.223	47.61	55.31	50.26	57.62
1955	.124	.196	.210	49.25	56.48	52.06	58.93
1960	.119	.184	.197	50.93	57.67	53.89	60.26
1965	.109	.163	.174	53.32	59.05	56.46	61.78
1970	.098	.141	.149	55.93	60.43	59.25	63.29
1975	.086	.118	.125	58.66	61.82	62.00	64.77

in 1940 infant mortality in Rio de Janeiro and Sao Paulo was about 75 percent of that estimated for the Northeast, by 1975 their infant mortality was only 54 percent of that in the Northeast. Hence, although infant and child mortality declined in all regions, differentials between the two extremes increased.

ADULT MORTALITY

Table 1, which presents final estimates of the expectations of life at birth and at exact age 5 (e_0 and e_5), reveals that adult mortality also declined steadily between 1940 and 1975. During this period, e_5 for both sexes combined increased by an annual average of 0.26 years, although the gains achieved were slightly smaller for males than for females. The values of e_0, obtained by splicing together child and adult mortality estimates, indicate that the combined child and adult mortality decline that took place between 1940 and 1975 amounted to an increase of about 32 percent in life expectancy, or an annual average increase of about 0.41 years. Life expectancy at birth in 1940 was 44.5 and 47 years for men and women, respectively; by 1975 it had reached 58.7 years for men and 62 years for women.

FERTILITY

In contrast with the steady, long-term decline in mortality from 1940 to 1975, Brazil's fertility has recently undergone a fast and fairly widespread decline which, according to the available evidence, started only around 1965 and gained momentum during the 1970s. Part A of Table 2 shows the final set of total fertility estimates for the 1940-78 period, which is also displayed graphically in Figure 17. According to these estimates, total fertility declined from about 6 children per woman in 1960 to 4.3 children in 1978, a reduction of about 40 percent. But even more striking than its sheer magnitude is the fact that most of this decline took place after 1970.

Although no smooth and consistent time series of total fertility estimates has been derived for individual regions, Part B of Table 2 presents estimates of total fertility by region for approximate periods. These estimates reveal that, as with child mortality, sharp differentials in fertility exist between the regions. Once more, the most developed regions, Rio de Janeiro and Sao Paulo, are characterized by substantially lower fertility than that observed in the rest of the country, although the almost universal decline that has taken place recently has tended to reduce differentials between the more developed regions and the regions of traditionally high fertility, such as the South (Region 3) and Center (Region 4). In contrast, the Northeast (Region 5) remains a high fertility area; although some reduction is evident, it still lags far behind the more developed regions of the country.

POPULATION GROWTH RATES

Figure 1 shows a plot of the overall rates of natural increase (birth rate minus death rate) that are consistent with the fertility and mortality estimates derived in this report. (Table 49 presents the final estimated birth rates, death rates, and rates of natural increase for males, females, and both sexes combined.) The trend followed by these rates during the 1940-80 period takes the form of an inverted U: increasing between 1940 and 1960-64 and declining thereafter. The increasing trend observed at first is due to the steady decline in mortality already noted, while the declining

TABLE 2 Summary of Final Fertility Estimates, 1940-78: Brazil

Part A. National Fertility Estimates

	Date								
	1940.0	1942.5	1947.5	1952.5	1957.5	1962.5	1967.5	1972.5	1977.5
Total Fertility	6.25	6.25	6.20	6.10	6.00	5.90	5.60	5.00	4.30

Part B. Regional Total Fertility Estimates

	Approximate Reference Date			
Region[a]	1945-50	1955-60	1965-70	1971-76
1	4.40	4.20	4.00	3.25
2	4.70	4.50	4.10	3.31
3	6.00	6.00	5.60	4.37
4	6.50	6.50	6.40	4.79
5	7.30	7.30	7.30	6.51
6	--	5.10	5.00	4.05
7	7.00	7.00	7.00	4.72
Total	6.20	6.09	5.85	4.48[b]

[a] See Table 3 for definition of the regions.

[b] When an estimate corresponding to the rural population of Region 7 is added to the calculations, this estimate is revised to 4.60.

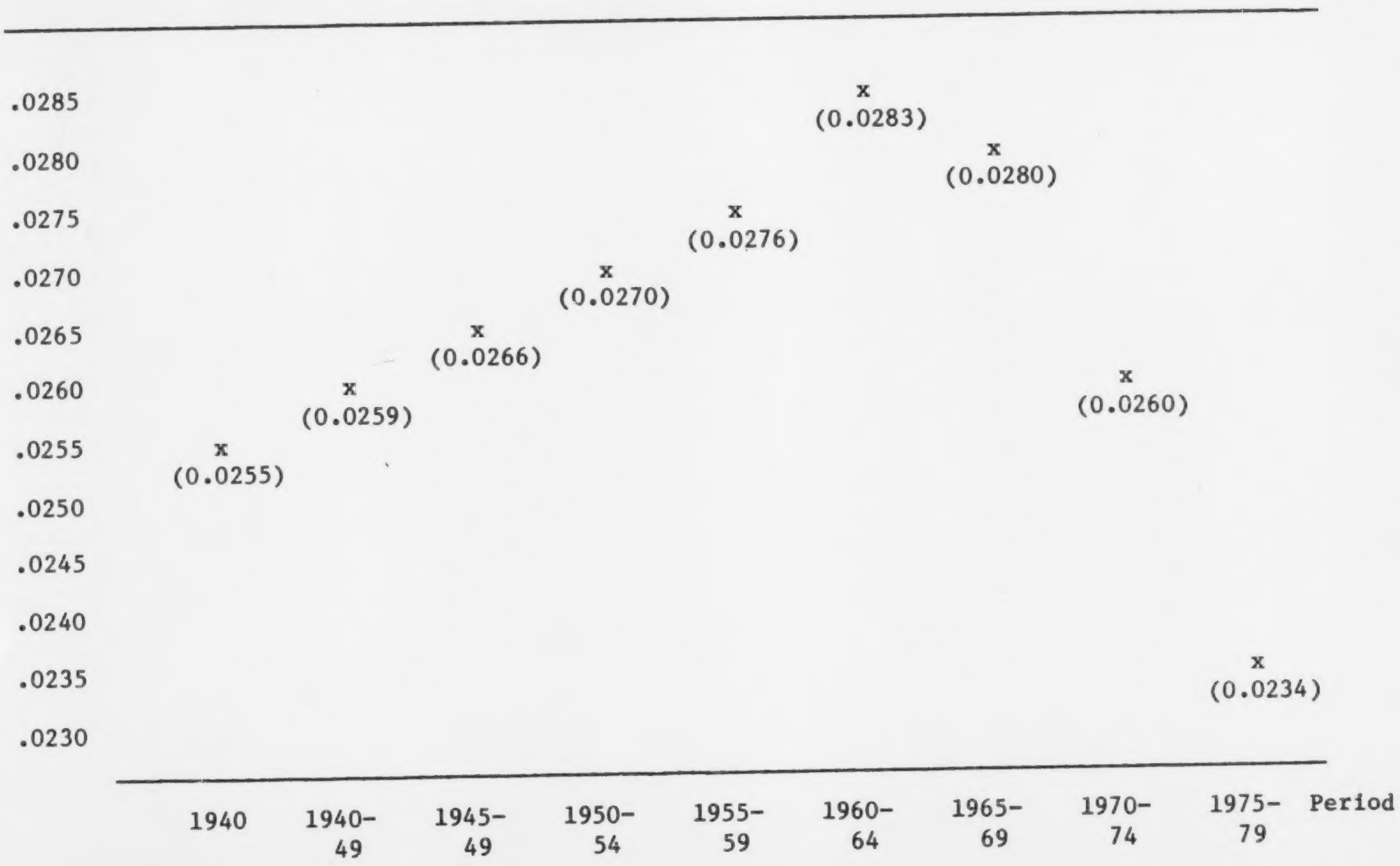


FIGURE 1 Estimated Rates of Natural Increase, 1940-80: Brazil

trend since the mid-1960s is due mainly to the declining trend in fertility. According to the estimates in Table 49, in 1940 the Brazilian population was growing at an average annual rate of 2.55 percent, which increased slowly to a peak of 2.83 percent during 1960-64, and has been declining since, reaching levels even lower than that of 1940. During 1975-79 it is quite likely that the Brazilian population grew by only 2.34 percent annually, and further reductions are expected during the 1980s.

CHAPTER 1

INTRODUCTION

BRAZIL: ITS PLACE IN THE WORLD

One-third of all Latin Americans are Portuguese-speaking and live in Brazil, the largest country in the region and the sixth most populous country in the world. With a population of approximately 119 million according to the most recent census (1980), Brazil experienced an annual growth rate of 2.46 percent during the 1970-80 decade (also according to census counts). Were this rate to continue, Brazil's population would double in some 28 years, reaching 195 million by the end of this century. Because of the social and economic implications that the future evolution of the country's population has, it is important for planners to know whether any changes are taking or have taken place in demographic trends. Of particular importance is the evolution of fertility, which seems to have decreased substantially in recent years. Although the socioeconomic characteristics and general development level of the Brazilian population lend credence to the existence of such a change, careful examination of the evidence is necessary to establish whether fertility has, in fact, declined, by how much, and since when. This report attempts to answer these questions, so as to provide planners with better bases on which to forecast the country's future needs.

The geopolitical importance of Brazil has conditioned internal attitudes and policies about population (generally pro-natalist) as well as the perception of other countries, especially those that surround it (see Melo-Moreira et al., 1978). Brazil borders all the countries of South America except Chile and Ecuador (see Figure 2). In a wider context Brazil is often seen as an emerging Third World power that is richly endowed with

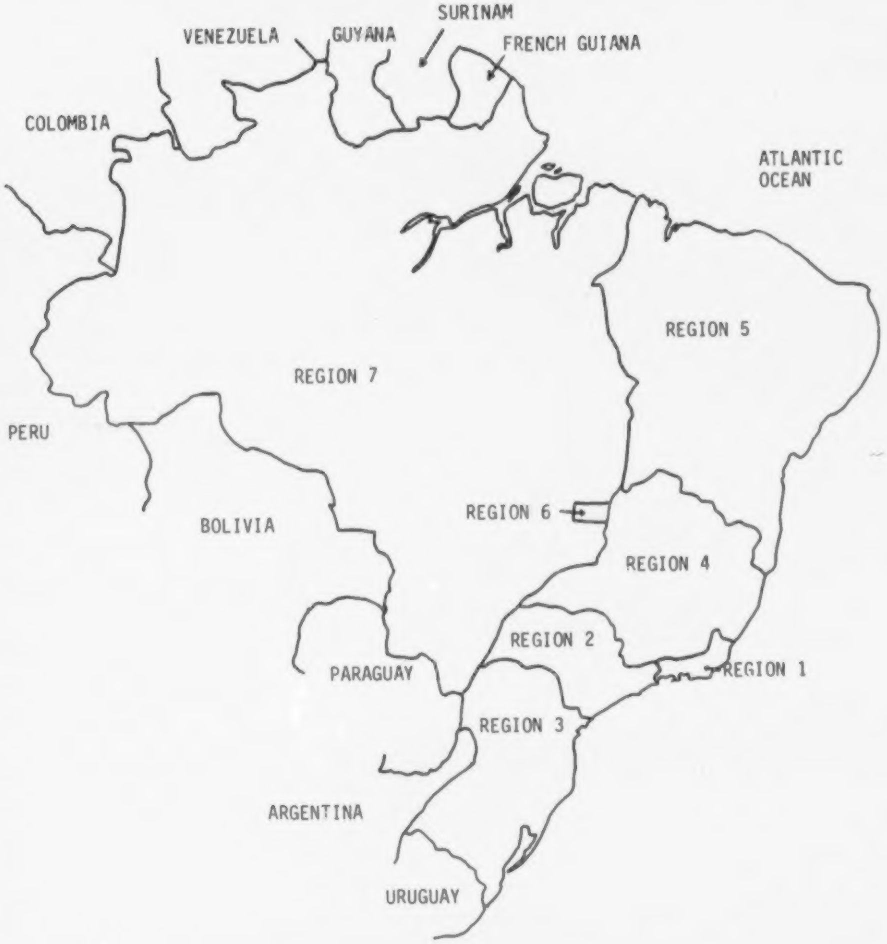

VENEZUELA
GUYANA
SURINAM
FRENCH GUIANA
COLOMBIA
ATLANTIC OCEAN
REGION 5
REGION 7
PERU
REGION 6
BOLIVIA
REGION 4
REGION 2
PARAGUAY
REGION 1
REGION 3
ARGENTINA
URUGUAY

FIGURE 2 Brazil and its Seven Main Regions

mineral resources and abundant agricultural land. Brazilian products are now exported competitively all over the world. Its industrial capacity is the largest in the developing world. Brazilian companies are building railroads in Africa, constructing dams in Venezuela, and extracting oil in Iraq. For all its natural and physical advantages, Brazil currently suffers from lack of domestically produced energy. Oil and coal reserves are small and impose a severe brake on what is otherwise a booming economy. On the other hand, hydroelectric potential is high and underdeveloped. Nuclear power plants are being built with the expectation that the dependency on oil imports can be offset, at least in part.

BRAZIL: ITS GEOGRAPHY

Brazil is the largest country in the South American subcontinent, comprising approximately 48 percent of its territory. Traversed by the equator in the North, most of the country lies in the southern hemisphere and its climates range from tropical to temperate. It can be divided into five major geographical regions, each having distinctive characteristics not only geographically, but also socially and economically. The seven regions used by the Brazilian Census Bureau (IBGE) in analyzing and tabulating demographic data may be matched to the five geographical regions by grouping. The definition of these "statistical" regions in terms of states and national territories is presented in Table 3, and Figure 2 shows their physical location.

Two geographical regions, the North and the Central West, make up statistical Region 7. The North comprises most of the Amazon basin and constitutes 42 percent of the country's territory. It is very sparsely populated (most of its population is concentrated in the urban areas of Manaus and Belem) and its inhabitants are a very small proportion of the total Brazilian population. The Central West, formed by the states of Goias and Mato Grosso, comprises 22 percent of the national territory and is also fairly underpopulated. Agriculture is the main economic activity in this region and the availability of unexploited land has attracted many new settlers since 1960. The Central West also contains the capital of Brazil, Brasilia, which alone constitutes statistical Region 6. Since its creation in the late 1950s, it has also been a center of attraction for new settlers.

TABLE 3 Definition of Brazil's Regions

Region	State
1	Guanabara Rio de Janeiro
2	Sao Paulo
3	Parana Santa Catarina Rio Grande do Sul
4	Minas Gerais Espiritu Santo
5	Maranhao Piaui Ceara Rio Grande do Norte Paraiba Pernambuco Alagoas Sergipe Bahia
6	Distrito Federal
7	Goias Mato Grosso Acre Amazonas Para Territorio de Rondonia Territorio de Roraima Territorio de Amapa

The remaining three geographic regions are located along the eastern coastline of the country. In the north, the Northeast (statistical Region 5) is composed of nine states and occupies 18 percent of Brazil's territory. About 30 percent of the Brazilian population inhabits this region, including approximately 41 percent of the country's rural population. Agricultural activities are predominant, but the relatively high population density and the low level of land availability make it a relatively poor region, whose contribution to total national income (about 12 percent) does not match its share of the population.

Statistical regions 1, 2, and 4, located immediately south of the Northeast, constitute the Southeastern geographical region. It contains Brazil's urbanized industrial heartland and is by far the most prosperous region of the country. Although it occupies only 11 percent of the national territory, its inhabitants constitute about 41 percent of the Brazilian population. They are concentrated mainly in the country's largest urban areas: Sao Paulo, Rio de Janeiro, and Minas Gerais.

At the southernmost tip of the country, comprising the states of Parana, Santa Catarina, and Rio Grande do Sul, is the fairly prosperous South Region (statistical Region 3). Endowed with good land for agriculture and a moderate level of industrial development, its inhabitants enjoy a per capita income equal to the nation's average. Approximately 17 percent of Brazil's population lives in this region.

For reasons that will become more apparent later, the analysis of Brazilian demographic data must take into account these regions and their different characteristics. Given the size of the Brazilian population, some of the regions have as many inhabitants as some other Latin American countries. Therefore, the study of their demographic characteristics is important in its own right.

DATA SOURCES

The history of demographic data sources in Brazil is not very long, and most of them do not achieve the quality or completeness that would be desirable. True censuses (in the modern sense of the term) began to be conducted only during the latter part of the nineteenth century, and vital registration, although required by law, has not been statistically adequate during most of this century. Fortunately, these data-gathering mechanisms have been, in general, improving with time. In conjunction with several sample surveys carried out during 1970-80, they provide a fairly adequate basis for estimating recent levels of certain demographic parameters. The sections that follow present detailed descriptions of the different data sources available, placing special emphasis on those pertaining to the 1940-79 period.

Censuses

Brazil's first official census was carried out in 1872. Unfortunately, its results were affected by both political instability and administrative inefficiency. Following this first census, there were a series of attempts to continue periodic enumerations, but a good number of them never took place. The censuses of 1880, 1910, and 1930 were cancelled. Among those that managed to get started, but were not completed, are the censuses of 1890 and 1900 (Merrick and Graham, 1979). The 1920 census, although completed, appears to have overcounted the population by about 12 percent (Mortara, 1970a).

In 1940 the Brazilian Census Bureau (IBGE) began to plan, carry out, and publish population enumerations that met international standards of design and collection. To date there are only three complete and reliable censuses of Brazil's population: 1940, 1950, and 1970. The 1960 census is not included in this category because, due to administrative problems in the early 1960s, publication of the data it gathered broke down after only a few volumes of data at the state level were completed. Not until 1977 did detailed tabulations at the national level appear. However, these were obtained from a sample of the original census returns, the only subset of the returns still available. Therefore, published volumes of the 1960 census are divided into two series: those published during the 1960 decade according to the original tabulation plan, and those published in 1977 on the basis of a sample of all returns. There are some doubts about the reliability of the latter. Tables 4 and 5 summarize the main results of the 1940-70 censuses. In addition, some preliminary results from the 1980 census are shown.

According to Table 4, the country has been experiencing a steady increase in urbanization, as measured by the proportion of the population living in urban areas. This proportion increased from some 31 percent in 1940 to about 56 percent in 1970, following an almost constant annual rate of increase between 1950 and 1970. If this rate were maintained during the 1970-80 decade, the population living in urban areas by 1980 would constitute over 70 percent of the total. It seems more likely, however, that a lower rate may have prevailed so that the

TABLE 4 Enumerated Population by Sex and Residence According to Different Censuses, 1940-80: Brazil

Census Date	Date in Years	Population Counts			Sex Ratio	Percentage	
		Male	Female	Both Sexes		Urban	Rural
1-IX-1940	1940.67	20,627,061	20,625,967	41,253,028[a]	1.0001	31.24	68.76[b]
1-VII-1950	1950.50	25,900,927	26,075,430	51,976,357[a]	0.9933	36.16	63.84[b]
1-IX-1960	1960.67	35,059,546	35,131,824	70,191,370[c]	0.9979	44.93	55.07[c]
1-IX-1970	1970.67	46,331,343	46,807,694	93,139,037[d]	0.9898	55.92	44.08[d]
1-IX-1980	1980.67	59,152,904	59,946,088	119,098,992[e]	0.9868	n.a.	n.a.

[a] From IBGE (1956).
[b] From CICRED (1975:29).
[c] From IBGE (1967-77).
[d] From IBGE (1973).
[e] From IBGE (1981).

TABLE 5 Average Annual Growth Rates by Sex for Different Intercensal Periods, 1940-80: Brazil

Intercensal Period	Intercensal Growth Rates (percent)		
	Male	Female	Both Sexes
1940-50	2.32	2.38	2.35
1950-60	2.98	2.93	2.95
1960-70	2.79	2.87	2.83
1970-80	2.44	2.47	2.46

70 percent figure may be viewed as an upper bound of the proportion of the population living in urban areas in 1980. It should be noted, perhaps, that the definition of urban areas in Brazil is mainly of an administrative nature and that it is not necessarily linked to the population size.

Table 4 shows the total population counts by sex for each of the censuses. Notice that the sex ratio of the population (proportion of males per female) has fluctuated somewhat and was considerably lower in 1970 than in 1940. Sex differentials in migration, mortality, or census coverage are all possible causes of these variations.

Table 5 shows the average annual rates of growth prevalent during the different intercensal periods as calculated from the raw census counts. In broad terms, some acceleration of the population's growth is evident between 1940 and 1970, but the pattern of this acceleration is not smooth, since there appears to have been a drastic increase in the growth rate between the 1940s and the 1950s and a slight deceleration during the 1960s.

Table 6 lists the demographic information gathered by each of the censuses from 1940 to 1970. Notice that every one of them has included questions on children ever born and children surviving. Information of this type is needed to estimate mortality levels in childhood. Brazil is one of the very few countries possessing such a long series of data on this particular topic. Unfortunately, the series is not entirely consistent, because the questions asked by the different censuses have not been the same. For instance, both the 1940 and the 1970 censuses included questions on the number of children

TABLE 6 Information Collected by Each Census, 1940-70: Brazil

	Census Date			
Topic	1-IX-1940	1-VII-1950	1-IX-1960	1-IX-1970
Age	Date of birth	Date of birth	Age at last birthday (months if less than one year)	Date of birth
	If date of birth is not known, estimated age	If date of birth is not known, estimated age	--	If date of birth is not known, estimated age
Marriage[a]	Marital status (excluding divorce)	Marital status (including divorce)	Marital status of those not living in a union	Marital status of those not living in a union
			Type of union for those living with a partner	Type of union for those living with a partner
			If living in a union, year of union	
Fertility[a]	Children born alive	Children born alive or dead	Children born alive or dead	Children born alive
	Children born dead	Children surviving	Children surviving	Children born dead
	Children surviving			Children surviving
	Age at first birth			Births during the year preceding enumeration

Migration[a]	Place of birth (state or foreign country)	Place of birth (state or foreign country)	Place of birth (state or foreign country)	Place of birth (state or foreign country)
			Length of stay in present "municipio" of residence	Length of stay in present "municipio" of residence
			Place of last residence (state or foreign country)	Lenth of stay in present state of residence
				Place of last residence (state or foreign country)
				Rural/urban status of "municipio", of last residence

---

[a] Asked only of a 25-percent sample in 1960 and 1970.

born dead (stillbirths), while in 1950 and 1960 the question on children ever born referred to both children born alive and children born dead. The use of this ambiguous type of question introduces a systematic bias into the data gathered and requires that they be corrected before the estimation of child mortality is attempted.

Vital Registration

Brazil has had an operating vital registration system for most of this century. Because registration of vital events is required by law, operation of the registration system falls under the mandate of the Ministry of Justice. Up until 1971 this ministry was also charged with compiling and publishing vital statistics. Nevertheless, data gathered from the vital registration system were published only intermittently, and no great effort seems to have been made to assure either their accuracy or completeness. The actual registration of vital events is carried out via privately run "cartorios," which operate on the basis of fees charged to the public for each event registered. Even today, the distribution of cartorios in the different states is not homogeneous, with a few municipalities still lacking cartorios altogether. Under these conditions it is not surprising to find that, traditionally, data produced by the vital registration system have not been used in the estimation of demographic parameters.

In 1971, the Brazilian government officially assigned the task of compiling and publishing vital statistics to the Brazilian Census Bureau (IBGE). By 1973 IBGE's staff had redesigned the forms to register vital events, in most cases supplying precoded answers to the questions posed. Use of these forms has greatly accelerated the processing of information. Furthermore, a special effort is being made to ensure that all the cartorios in operation send to IBGE the forms filled during each period. This efficient operation has already permitted the publication of vital registration data for the years 1974 and 1975, which is used in this report to estimate adult mortality.

Sample Surveys

During the 1970s a new and important source of demographic information was added to Brazil's data base: the series of national household surveys known as PNADs (Pesquisa Nacional por Amostra de Domicilios). The PNAD surveys began in 1967 and followed the general guidelines of the Atlantida Project, whose aim was to measure employment trends. The sampling frame used to select the survey's sample was based on the 1960 census. With the results of the 1970 census a more accurate frame became available and a new PNAD series, consisting of yearly surveys, was undertaken. The type of data collected was expanded beyond employment to include other sociodemographic topics, which could be modified from year to year.

From their inception, the PNAD surveys were designed to produce regional estimates. The seven PNAD Regions shown in Table 3 and Figure 2, were defined for that purpose. Six of these regions comprise major geographic subdivisions of Brazil, while the seventh (Region 6) is the Federal District of Brasilia. Only the urban areas of Region 7 are covered by the PNAD surveys.

Not all the PNAD surveys have covered all seven regions. The 1971 PNAD took place only in the South (Regions 1, 2, and 3) and its results were never published. In 1972, the PNAD survey was carried out in five major regions (Region 7 was omitted) and in the Federal District. The 1973 PNAD was the first to cover all the PNAD regions and since then every survey has had the same coverage.

The type of demographic information gathered by each of the PNAD surveys conducted during the 1972-77 period is presented in Table 7. Every one of them has collected information that allows the indirect estimation of child mortality and fertility, however most of them do not contain questions that permit the indirect estimation of adult mortality. This is especially unfortunate since other sources of information on adult mortality are generally considered poor. Only in 1977 did the PNAD survey include a question on maternal orphanhood.

Table 7 lists no PNAD survey for the years 1974 and 1975 because instead of a normal PNAD, a rather ambitious survey known as ENDEF (Estudo Nacional da Despesa Familiar) was carried out by IBGE during that period. The purpose of that survey was to gather information about household expenditures and nutritional intake. The questionnaire used was lengthy and complicated, and the interviews themselves were quite intensive: each household was visited three times a day for an entire week. Not surprisingly, the field work for this survey took almost a year to be completed (from mid-1974 to

TABLE 7 Information Collected by Each of the PNAD Surveys: Brazil

Topic	Year of Survey			
	1972	1973	1976	1977
Age	Date of birth (day, month, and year)	Date of birth (day, month, and year)	Date of birth (month and year)	Date of birth (month and year)
	Age at last birthday	Age at last birthday	Age at last birthday	Age at last birthday
Marital Status	Marital status	Marital status	Marital status	Marital status
			Date of marriage	Whether or not in first union
Fertility	Children born alive	Children born alive	Children born dead	Children born dead
	Children born dead	Children born dead	Children dead	Children dead
	Children surviving	Children surviving	Children surviving	Children surviving
	Children born alive in the past 12 months	Children born alive in the past 12 months	Date of most recent live birth (month and year)	Date of most recent live birth (month and year)
			Identification of mother	Age at the birth of the first child
Migration	Place of birth	Place of birth	Place of birth	Place of birth
	Place of residence in September 1970 (census date)	Place of residence in September 1970 (census date)	Length of stay in present "municipio" of residence	Length of stay in present "municipio" of residence
	Length of stay in present address	Length of stay in present address	Place of previous residence	Place of previous residence
Orphanhood				Survival of mother

mid-1975) and its results are still not completely processed. The ENDEF, like any other PNAD, did include some demographic questions, such as children ever born and children surviving by sex, deaths in the household during the 12 months preceding the interview, and births to women aged 15 and over during the year preceding the interview. At present, preliminary tabulations of children ever born, children surviving, and births during the year preceding the survey for both sexes combined are available for the first six PNAD regions.

A word about the availability of the data gathered by the PNAD surveys is in order. As mentioned above, results of the 1971 survey were never published. Results for 1972 are available in mimeographed form at IBGE, and data on children ever born, children surviving, and births during the year preceding interview for the regions covered by this survey are used in this report. In 1973, the published report included only a distribution of the population by age and sex and several tables on socioeconomic topics. Therefore, fertility information from the 1973 PNAD was also obtained from unpublished tabulations available at IBGE. The published volumes for 1976 contain appropriate tabulations of all the demographic variables explored and they have served as the main source of information in this report. The published volumes of the 1977 PNAD contain data on children ever born and surviving, and unpublished tabulations on maternal orphanhood and births during the year preceding interview were obtained from IBGE. Data from the ENDEF were obtained in the form of preliminary tabulations for the first six regions. Overall, the PNAD series offers a very rich source of demographic data, well suited for the application of many of the indirect estimation techniques now available.

Description of the PNAD Sample

The sample on which all the 1970-79 PNAD surveys are based is a multi-stage probability sample, with "municipios" as primary sampling units, census tracts ("setores censitarios") as secondary units, census blocks ("subsetores censitarios") as tertiary ones, and households as the final units sampled. The sample is designed so that every household in a given region has the same probability of being selected. However, the probabilities of selection change from region to region. Therefore, although estimates for each region may be obtained directly from unexpanded data, they need to be weighted in order to properly represent the experience of the country as a whole.

In selecting the primary units that ultimately contain the households constituting the sample, the municipios were divided into two mutually exclusive sets: one containing only "municipios auto-representativos" (self-representative municipalities) and another containing all the rest. All the municipios in the first set (self-representative) necessarily provide some of the sampled households, that is, they are included as primary sampling units with probability one. All other municipios (the ones that are not self-representative) were stratified according to geographical location and two municipios were selected within each stratum. The probability of selection of each non-self-representative municipio was proportional to its population in 1970.

A municipio was classified as self-representative if it satisfied any of the three following criteria:

1. It had a population greater than or equal to the average population per municipio in the region considered according to the 1970 census count.
2. It belonged to a metropolitan area.
3. It had economic or social characteristics that made it outstanding.

At the second stage of selection, the census tracts belonging to each of the municipios selected in stage one were listed in order, beginning with those classified as urban and ending with those classified as rural. Each census tract in these lists was assigned a probability of selection proportional to the number of dwelling units it contained (according to the 1970 census). Then, using systematic sampling with a random starting point, a certain number of census tracts was selected. The exact number selected in each municipio depended, among other factors, on the average number of dwelling units per tract and on the sampling fraction that was to be attained. The urban-rural ordering used at this stage was intended to produce a stratification that enhances the theoretical representativity of the sample.

Some field work was necessary for the selection of tertiary units. The aim of this field operation (called "contagem rapida") was to count the number of dwelling units actually existing on the census tracts selected during the previous stage. On the basis of these dwelling counts, the census tracts were divided into subsectors of approximately equal size (the same number of households). The main objective of this operation was to limit the geographical spread of the sample and to reduce traveling and other costs. In theory, a sample spread over the entire census tract would be better, because it would produce smaller variances than one concentrated in a small number of subsectors. However, the expected reduction in variance did not seem to justify the extra cost involved. The selection of subsectors was carried out in a way that assured an equal probability of selection for each household, producing therefore a self-weighting sample within each region.

The fourth stage of the selection process required once more some field work. At this stage, the households present in each of the subsectors selected were listed and lists for each subsector were used to obtain the final household sample by means of systematic sampling with a random starting point. Approximately eight households were selected in each subsector.

The sampling plan described so far was followed in selecting the samples for the 1971, 1972, and 1973 PNAD surveys. The 1974-75 ENDEF was based on a somewhat different sampling scheme, since it aimed at producing estimates for metropolitan and nonmetropolitan areas separately. Furthermore, because the field work required by ENDEF was very intensive, selected households could not be as widely spread as those selected for other surveys. Greater concentration was achieved by using pairs of neighboring households as final sampling units.

In 1976 and 1977 the sampling design described above was modified again. The third stage of the sample selection was eliminated altogether (i.e. the selection of subsectors within a census tract) and households were selected directly from all those belonging to a given census tract. To make this selection possible, a complete listing of households in the selected census tracts was performed. This procedure allowed a wider geographical spread of the selected households, hence improving the expected variances.

Expansion of the PNAD Results

The ratio method, based on the existence of independent estimates of the population, has been used to expand the

PNAD data. The 1972 and 1973 PNADs were expanded on the basis of the projected Brazilian population classified by age and sex for each of the PNAD regions. Population projections were produced by the Brazilian Center for Demographic Studies (CBED) on the basis of the 1960-70 trends. A total of 22 factors (11 for each sex) was used to expand the population of each region.

In 1976 and 1977, in order to assess the quality of the CBED projections and to gather more information about the evolution of the Brazilian population, each of these PNAD surveys was preceded by a complete listing of members of the households constituting the census tracts in the sample. The results of these listings (called "listagems") show an age distribution with a relatively narrow base (a low proportion of children aged 0-4). This phenomenon is noticeable in both the 1976 and the 1977 listagems, and it suggests either a greater undercount of young children than that achieved by the 1970 census or a decline in fertility. IBGE has accepted the "listagem" results as true and has used them to modify the set of expansion factors used previously. Hence, the 1976 and the 1977 PNADs have been expanded by factors implying a somewhat different age structure.

Some Aspects of the PNAD Field Work

The questionnaires used in all the PNAD surveys are designed to gather information about each household selected and each of its members. Interviewers are advised to obtain all this information from the head of the household or, in his or her absence, from any household member who can provide it. Therefore, in general, information on the fertility of each woman in the household, for example, is probably not provided by the women themselves, but rather by the head of household.

The field work of the earlier PNAD surveys (1972 and 1973) took place during the last quarter of each year and lasted for approximately three months. In more recent years, expansion of the field staff has allowed completion of the survey in shorter periods (approximately one month), and the survey questions on events occuring during a given period have included specific reference dates (November 28 in 1976 and October 31 in 1977). Once more, the ENDEF is an exception, having required a year to be completed (from mid-1974 to mid-1975).

ORGANIZATION OF THE REPORT

Using data from the sources described in this chapter, the succeeding chapters present estimates of levels and trends of fertility and mortality in Brazil and each of its main regions during approximately the 1950-76 period. Mortality estimates are presented in Chapter 2, followed by fertility in Chapter 3. Chapter 4 contains a summary of the main conclusions reached.

CHAPTER 2

MORTALITY

ESTIMATING CHILDHOOD MORTALITY

In most of the developing world, the traditional sources of information needed to estimate mortality rates, whether in childhood or at later ages, have been found sufficiently deficient to warrant the search for alternative data sources and estimation procedures. Mortara (1970a) was the first to use the proportions of children dead among those ever born as reported by women of different ages as indicators of mortality in childhood. Brass (1964) developed this idea further, proposing a procedure that permitted the observed proportions of children dead to be converted into life-table probabilities of dying between birth and a set of exact ages x. Thus, for example, ${}_2q_0$, the probability of dying between birth and exact age 2, can be estimated from the proportion of children dead among those ever borne by women aged 20-24; ${}_3q_0$ can be estimated from the same proportion for women aged 25-29; ${}_5q_0$ from the information of those aged 30-34, and ${}_{10}q_0$, ${}_{15}q_0$, and ${}_{20}q_0$ from that of women aged 35-39, 40-44, and 45-49, respectively. The original Brass estimation procedure was derived from data simulated by using mathematical models of the demographic processes involved. In recent years, the availability of better and somewhat more flexible models has led to the creation of new versions of the Brass procedure. The one proposed by Trussell (United Nations, 1983) has been used here to derive estimates of mortality in childhood.

Sources and Type of Data

Brazil possesses a fairly long history of statistics on children ever born and children surviving. Questions on these topics have been included in every census since 1940 (see Table 6). Furthermore, all the PNAD surveys whose data are available have also included questions on these topics (see Table 7), so that the series of child mortality estimates obtained from census information can be expanded.

In 1940, women aged 12 and over were asked to declare the number of children born alive they had ever had, the number of those born dead, and the number who were alive at the time of the census. Analysis of the 1940 results revealed that women had declared a very high proportion of children born dead. Apparently, the instructions accompanying the questionnaires used in this census did not state explicitly that pregnancies terminating before the seventh gestational month should not be counted as stillbirths. Furthermore, in 1940 a large proportion of the urban population filled in the census questionnaires directly, without the help or presence of a census enumerator, thus increasing the possibility of respondent's error. Based on the results of the 1940 census, Mortara suggested eliminating a specific question on children born dead in subsequent censuses. In consequence, only two questions on fertility were asked during the 1950 and 1960 censuses: one on the number of children ever born, including those born dead, and another on the number surviving by the date of the census. In those two censuses, instructions accompanying the question on children ever born, whether alive or dead, clearly stated that only those pregnancies lasting more than seven months should be counted.

The 1970 census gathered fertility data only from a 25 percent sample of the population and included, as in 1940, two separate questions on children ever born: one on children born alive and another on children born dead. Stillbirths were defined again as dead children resulting from pregnancies lasting at least seven months. Table 8 shows the proportions of children born dead among those ever borne by women in five-year age groups, according to the 1940 and the 1970 censuses. Note that the 1940 figures reveal increasing proportions of children born dead with age of mother, while the ones for 1970 display a U-shaped relationship with respect to age (given the usual relationship between mother's age and child mortality, the latter are more plausible). Furthermore, while in 1940 the range of variation of the proportions dead is of approximately 3 percent, in 1970 it is of little more than one percent. Also striking is the fact

TABLE 8 Percentage of Children Born Dead Among Those Ever Born by Age of Mother, 1940 and 1970: Brazil

	Percentage of Children Born Dead	
Age Group	1940	1970
15-19	5.67	3.03
20-24	6.97	2.75
25-29	7.46	2.81
30-34	7.68	3.03
35-39	8.06	3.25
40-44	8.40	3.59
45-49	8.63	3.85

that, on average, the proportion born dead in 1940 was approximately twice that observed in 1970. The anomalies present in the 1940 data have already been discussed by Mortara (1947), Leite (1973), and Medeiros-Frias and Rodrigues (1979). All these authors agree that the 1940 figures on children born dead are an overestimate of the true incidence of stillbirths.

Since 1970 all the PNAD surveys have gathered information about children ever born, children surviving, and children born dead. However, tabulations of the latter have not been made consistently. In 1976, a year for which these data are available, the recorded proportion of children born dead is substantially higher than that recorded by the 1970 census (by about 70 percent) but still lower than that recorded in 1940. The better quality of the interviewers charged with carrying out the PNAD surveys is likely to be responsible for this differential, but its existence increases the uncertainty surrounding the estimation of the true incidence of stillbirths.

Finally, notice that according to Table 7 the questions asked in the PNAD surveys to obtain information on children ever born have not always been the same. In 1972 and 1973 a direct question on children ever born alive was posed, while from 1974 onward the number of children ever born was constructed from the reported number of children dead and the number surviving. This change in the type of questions used may have some effect on the quality of reporting.

Correction of the Data on Children Ever Born for 1950 and 1960

Because the data on children ever born recorded by the 1950 and 1960 censuses include both children born alive and children born dead (stillbirths), they must be corrected before attempting to estimate child mortality; otherwise, the proportions of children dead, required as input by the indirect estimation procedures, would be too low and child mortality would be underestimated.

Several correction schemes have been proposed. Mortara (1970a) and Carvalho (1974) assumed that 5 percent of the children ever born declared in the 1950 and 1960 censuses were, in fact, stillbirths. This proportion was used to adjust all data on children ever born, irrespective of region or age of mother, before the child mortality estimation procedure was applied. Given that the incidence of stillbirths is not constant with respect to mother's age and that it also appears to vary according to region (it is linked to the overall mortality level of each region), this procedure does not seem very satisfactory. However, before the publication of the 1970 census results, more realistic corrections were not feasible.

Medeiros-Frias and Rodrigues (1979) used the 1970 state-level data to fit an exponential model relating the incidence of dead children among fertile women (women who had had at least one child) of a given age group to the incidence of stillbirths among the same women. Because the model was fitted separately to data of each age group, variations with respect to age were adequately reflected by it. The authors report that the percent of the variance explained by the fitted equations falls generally within the 93-96 percent range, the only exception being the equation fitted to data for the 15-19 age group which explains only 77 percent of the variance. At a second stage, Medeiros-Frias and Rodrigues fitted polynomials on mother's age to the parameters estimated for each age group in order to derive a single equation relating mother's age and incidence of children dead to the incidence of stillbirths. No measures of the overall goodness of fit of this equation are given, but they are not likely to be better than the 93-96 percent range quoted above.

An examination of the state-level data on children ever born, surviving, and born dead from the 1970 census, reveals that, for each age group of mother, a very satisfactory linear relationship prevails between the ratios CS/CEB and CS/(CEB + CBD), where CS denotes children surviving, CEB stands for children born alive (ever born), and CBD is the reported number of children born dead. Figure 3 displays plots of the points defined by these ratios. Panel 1 of the figure refers to women aged 15-19, Panel 2 to those aged 20-24. Plots for other age groups are not shown, but in all cases the linear relationship evident in the two panels of Figure 3 is equally strong. Note, however, that three deviant points appear in each panel of Figure 3. Even for the age groups not shown, the same points were found to deviate fairly markedly from the general trend of the rest. These points correspond to the states of Alagoas (AL), Goias (GI), and Paraiba (PB). Because of the distorting influence that they may exert on the estimates of the parameters relating linearly CS/CEB to CS/(CEB + CBD), they were excluded from the fitting process.

Straight lines were fitted via least-squares regression to each set of points [CS/(CEB + CBD), CS/CEB] referring to a particular age group. Table 9 shows the values of the estimated parameters and the proportion of the variance (R^2) explained in each case. Note that these proportions are substantially higher than those reported by Medeiros-Frias and Rodrigues (being about 99 percent

TABLE 9 Estimated Regression Coefficients Defining the Linear Relationship Between CS/CEB and CS/(CEB+CBD), and Measures of the Goodness of Fit of This Model: Brazil

Age Group	a	b	R^2
15-19	.1845	.8144	.9665
20-24	.1317	.8705	.9918
25-29	.1021	.9044	.9949
30-34	.1045	.9006	.9927
35-39	.0991	.9077	.9954
40-44	.0926	.9163	.9939
45-49	.0838	.9272	.9970

Note: Alagoas, Goias, and Paraiba were excluded in all cases.

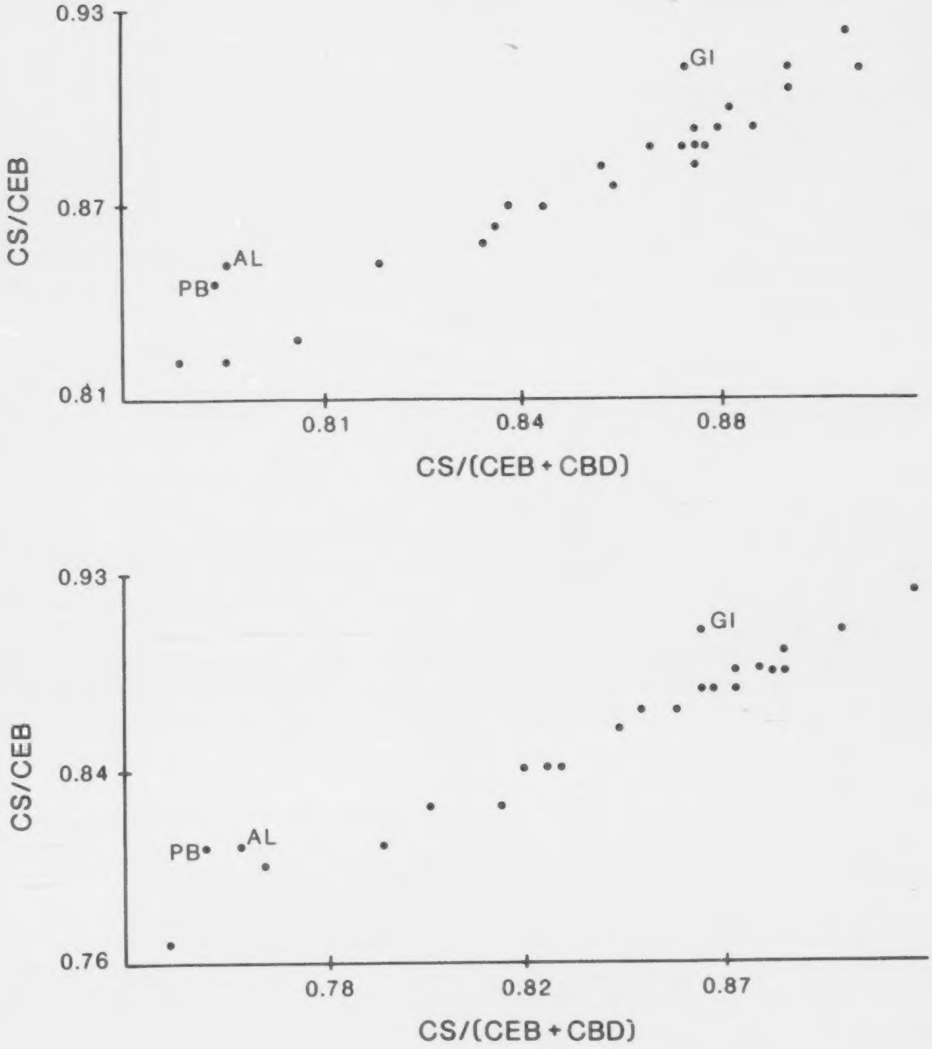


FIGURE 3 Linear Relationship Between Two Ratio Measures of Child Mortality: Children Surviving of Children Ever Born (CS/CEB) and Children Surviving of Children Born Alive and Children Born Dead (CS/CEB + CBD), 1976 Census: Brazil

in most cases). This fact indicates that the model suggested here, namely:

$$\frac{CS}{CEB} = a + b \frac{CS}{CEB + CBD} \qquad (1)$$

provides a better fit to the data than does the one suggested by Medeiros-Frias and Rodrigues. Therefore, equation (1) was used to adjust the 1950 and 1960 child mortality data.

Comparison and Assessment of the Child Mortality Estimates

Estimates of child mortality derived from the data sources corresponding to the 1950-77 period are displayed in Tables 10 to 17. Estimates are presented for Brazil as a whole and for each of its regions. Notice, however, that in 1950 Region 6 (Brasilia) was not identified as a separate entity (it was part of Region 7) and that because none of the PNAD surveys covers Region 7 as a whole, no estimates for this region are presented beyond 1970.

The estimates shown in Tables 10 through 17 are somewhat unorthodox, because they do not represent the actual estimates of child mortality yielded by the Brass-type method used, that is, the typical ${}_xq_0$ estimates associated with different age groups of mother. Instead, they are the mortality levels that these ${}_xq_0$ values imply within the "South" family of model life tables proposed by Coale and Demeny (1966).

It is usual practice to assess the consistency of the ${}_xq_0$ estimates derived from data on children ever born and surviving with reference to a given set of models. Ideally, the set used should closely represent the pattern of mortality prevalent in the population under study; however, in countries where indirect methods must be used to estimate mortality, independent evidence of reasonable quality that would permit a judicious choice of model is often unavailable. Brazil is a case in point, where the lack of reliable data makes the choice of model largely a matter of guesswork. The "South" model has been used in this analysis because it is generally accepted as a good representation of mortality patterns in Latin American countries (United Nations, 1967) and because it appears to yield the most consistent estimates of the growth rate

TABLE 10 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1950 Census Data: Brazil

Age Group of Mother	Region 1		Region 2		Region 3		Region 4	
	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1948.3	15.10	1948.4	15.11	1948.3	16.05	1948.4	13.73
25-29	1946.4	15.07	1946.6	15.33	1946.5	16.47	1946.7	14.29
30-34	1944.0	14.69	1944.4	14.82	1944.2	16.52	1944.4	14.23
35-39	1941.4	14.06	1941.8	14.23	1941.7	16.14	1941.9	14.02
40-44	1938.5	13.60	1938.9	13.88	1938.9	16.08	1939.1	13.76
45-49	1935.3	13.17	1935.8	13.72	1935.7	16.02	1936.0	13.69

Age Group of Mother	Region 5		Region 6		Region 7		Whole Country	
	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1948.4	9.10	--	--	1948.3	14.02	1948.4	12.58
25-29	1946.6	10.23	--	--	1946.4	14.20	1946.6	13.14
30-34	1944.4	10.54	--	--	1944.2	13.97	1944.3	13.15
35-39	1942.0	10.66	--	--	1941.6	13.20	1941.8	12.94
40-44	1939.2	10.64	--	--	1938.8	12.62	1939.0	12.80
45-49	1936.1	10.79	--	--	1935.7	12.35	1935.9	12.83

TABLE 11 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1960 Census Data: Brazil

	Region 1		Region 2		Region 3		Region 4	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1958.7	18.65	1958.7	18.55	1958.7	18.78	1958.7	16.35
25-29	1956.7	18.67	1956.7	18.59	1956.8	18.97	1956.9	16.66
30-34	1954.3	17.97	1954.2	18.06	1954.4	18.76	1954.6	16.41
35-39	1951.5	16.84	1951.5	16.83	1951.7	18.10	1952.0	15.80
40-44	1948.5	15.89	1948.5	15.93	1948.8	17.57	1949.1	15.15
45-49	1945.3	15.30	1945.3	15.43	1945.6	17.22	1945.9	14.85

	Region 5		Region 6		Region 7		Whole Country	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1958.6	10.28	1958.3	14.61	1958.5	17.01	1958.6	15.04
25-29	1956.9	11.10	1956.3	14.52	1956.6	17.12	1956.8	15.52
30-34	1954.8	11.26	1954.0	15.18	1954.3	16.69	1954.5	15.22
35-39	1952.3	11.43	1951.3	14.50	1951.6	16.00	1951.9	14.72
40-44	1949.6	11.36	1948.5	13.41	1948.7	15.47	1949.0	14.29
45-49	1946.4	11.57	1945.4	14.34	1945.6	14.94	1945.8	14.12

TABLE 12 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1970 Census Data: Brazil

	Region 1		Region 2		Region 3		Region 4	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1968.6	17.62	1968.6	18.18	1968.6	18.63	1968.7	16.82
25-29	1967.0	18.31	1967.0	18.61	1966.9	19.09	1967.1	17.37
30-34	1964.9	17.89	1965.0	18.47	1964.7	18.97	1965.1	17.09
35-39	1962.6	17.21	1962.6	17.83	1962.3	18.44	1962.8	16.71
40-44	1960.0	16.34	1960.0	17.22	1959.5	18.16	1960.1	16.22
45-49	1956.8	15.80	1956.8	16.48	1956.4	17.69	1957.0	15.78

	Region 5		Region 6		Region 7		Whole Country	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1968.6	12.76	1968.6	16.77	1968.5	17.65	1968.6	16.11
25-29	1967.0	13.06	1966.8	17.31	1966.7	17.83	1966.9	16.45
30-34	1965.0	12.73	1964.6	16.72	1964.6	17.51	1964.9	16.17
35-39	1962.6	12.43	1962.1	16.02	1962.1	17.01	1962.5	15.74
40-44	1960.0	12.12	1959.4	15.35	1959.4	16.41	1959.8	15.24
45-49	1956.8	12.05	1956.2	14.67	1956.3	15.97	1956.7	14.90

TABLE 13 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1972 PNAD Data: Brazil

	Region 1		Region 2		Region 3		Region 4	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1970.7	19.31	1970.8	20.02	1970.8	20.54	1970.9	18.97
25-29	1969.0	20.53	1969.1	20.73	1969.2	20.54	1969.4	19.34
30-34	1967.0	20.12	1967.1	20.42	1967.1	19.53	1967.5	18.64
35-39	1964.7	19.13	1964.8	19.19	1964.7	19.02	1965.3	17.51
40-44	1962.1	18.45	1962.2	18.93	1962.1	18.79	1962.8	17.32
45-49	1959.0	17.46	1959.1	17.81	1958.9	18.26	1959.6	16.51

	Region 5		Region 6		Region 7		Whole Country	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1970.7	12.30	1970.7	19.06	--	--	1970.8	16.58
25-29	1969.1	12.70	1969.1	19.08	--	--	1969.2	17.06
30-34	1967.2	12.03	1967.2	18.51	--	--	1967.2	16.38
35-39	1965.0	12.00	1965.0	17.53	--	--	1964.9	16.04
40-44	1962.4	11.37	1962.5	16.69	--	--	1962.3	15.50
45-49	1959.3	11.24	1959.4	16.40	--	--	1959.2	14.90

TABLE 14 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1973 PNAD Data: Brazil

	Region 1		Region 2		Region 3		Region 4	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1971.7	20.43	1971.7	20.44	1971.9	19.83	1972.0	19.06
25-29	1970.1	19.90	1970.2	20.84	1970.1	21.07	1970.3	19.27
30-34	1968.2	19.84	1968.3	20.40	1967.8	20.20	1968.3	18.47
35-39	1965.9	19.32	1966.1	19.69	1965.2	20.06	1965.9	16.80
40-44	1963.4	17.64	1963.6	18.95	1962.3	19.42	1963.1	17.65
45-49	1960.2	17.58	1960.5	18.19	1959.1	18.82	1960.0	16.55

	Region 5		Region 6		Region 7		Whole Country	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1971.8	12.26	1971.8	18.98	--	--	1971.8	16.76
25-29	1970.1	13.11	1970.2	19.41	--	--	1970.1	17.43
30-34	1968.0	11.86	1968.2	18.76	--	--	1968.0	16.54
35-39	1965.6	11.72	1965.9	18.35	--	--	1965.7	16.08
40-44	1963.0	11.32	1963.4	17.13	--	--	1963.0	15.70
45-49	1959.8	10.90	1960.2	16.01	--	--	1959.8	15.04

TABLE 15 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1974-75 ENDEF Data: Brazil

	Region 1		Region 2		Region 3		Region 4	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1972.8	18.78	1972.9	20.18	1973.0	20.39	1973.1	18.13
25-29	1971.2	18.86	1971.3	19.31	1971.4	19.70	1971.6	17.24
30-34	1969.2	18.47	1969.5	18.27	1969.4	19.29	1969.7	18.19
35-39	1966.9	18.25	1967.3	17.97	1967.2	18.78	1967.6	16.86
40-44	1964.3	17.62	1964.8	17.05	1964.6	17.40	1965.0	15.59
45-49	1961.2	16.65	1961.7	16.54	1961.4	17.40	1961.9	15.56

	Region 5		Region 6		Region 7		Whole Country	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1972.8	12.65	1973.0	19.59	--	--	1972.9	16.84
25-29	1971.3	11.63	1971.4	18.28	--	--	1971.4	15.92
30-34	1969.6	11.66	1969.3	18.37	--	--	1969.5	15.82
35-39	1971.5	11.31	1967.0	16.76	--	--	1967.4	15.25
40-44	1965.1	10.96	1964.4	16.71	--	--	1964.9	14.65
45-49	1962.0	11.38	1961.2	15.49	--	--	1961.7	14.53

TABLE 16 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1976 PNAD Data: Brazil

	Region 1		Region 2		Region 3		Region 4	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1974.6	21.25	1974.6	20.18	1974.8	18.93	1974.8	19.20
25-29	1973.0	20.72	1973.0	20.73	1973.1	20.97	1973.3	19.57
30-34	1971.2	20.91	1971.0	20.23	1971.0	20.42	1971.4	19.67
35-39	1969.1	19.70	1968.8	19.81	1968.6	19.61	1969.2	19.10
40-44	1966.6	19.02	1966.2	19.90	1965.9	19.88	1966.6	17.53
45-49	1963.5	18.58	1963.1	18.58	1962.8	19.46	1963.5	17.89

	Region 5		Region 6		Region 7		Whole Country	
Age Group of Mother	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1974.7	13.46	1974.8	20.90	--	--	1974.7	17.30
25-29	1973.0	14.95	1973.0	20.58	--	--	1973.0	18.42
30-34	1971.0	14.46	1970.8	19.93	--	--	1971.0	18.01
35-39	1968.6	13.13	1968.3	18.99	--	--	1968.8	16.97
40-44	1966.0	12.57	1965.5	18.68	--	--	1966.2	16.61
45-49	1962.8	12.35	1962.3	17.72	--	--	1963.1	16.22

TABLE 17 Reference Dates and South Mortality Levels Consistent with the Estimates of Child Mortality Obtained from the 1977 PNAD Data: Brazil

Age Group of Mother	Region 1		Region 2		Region 3		Region 4	
	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1975.7	20.59	1975.6	20.09	1975.8	19.15	1975.9	19.17
25-29	1974.0	21.55	1973.9	20.49	1973.9	21.02	1974.2	20.02
30-34	1971.9	19.79	1971.8	20.73	1971.7	20.31	1972.1	18.54
35-39	1969.6	20.05	1969.4	19.82	1969.1	19.58	1969.7	18.88
40-44	1966.9	19.27	1966.8	18.76	1966.2	19.53	1966.9	18.28
45-49	1963.8	18.40	1963.6	18.62	1963.1	19.03	1963.7	17.65

Age Group of Mother	Region 5		Region 6		Region 7		Whole Country	
	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level	Reference Date	South Mortality Level
20-24	1975.6	15.02	1975.6	21.27	--	--	1975.7	18.01
25-29	1974.0	15.14	1974.0	19.97	--	--	1974.0	18.55
30-34	1972.0	14.32	1971.9	18.90	--	--	1971.9	17.78
35-39	1969.7	13.55	1969.6	19.18	--	--	1969.5	17.23
40-44	1967.2	13.01	1967.0	18.48	--	--	1966.9	16.74
45-49	1964.0	12.42	1963.9	17.91	--	--	1963.7	16.10

for the country as a whole when methods based on model stable populations are used (United Nations, 1983). However, even if "South" could be proven to be the best model for the Brazilian population as a whole, it does not necessarily follow that it is the best model for each of the country's regions. Again, lack of reliable data precludes the exploration of regional variations in the pattern of child mortality, and in order to avoid the introduction of spurious differentials, the "South" model has been used in analyzing both national and regional data.

A rapid examination of Tables 10 through 17 reveals that child mortality has been declining steadily during the past 40 years, at both the regional and national level. However, this global decline in mortality has not been accompanied by a comparable reduction of the regional differentials revealed by the 1950 data. According to Table 10, a differential of roughly three and one-half mortality levels was apparent in 1938-44 between the fairly developed Regions 1 and 2 (Rio de Janeiro and Sao Paulo) and the underdeveloped Region 5 (the Northeast). According to the 1977 data (Table 17), this differential had increased to about six levels by 1969-72, with the Northeast exhibiting very high child mortality. In other words, the gains in the country's expectation of life achieved by the reduction of infant and child mortality between the early 1940s and the early 1970s have not been equally distributed among Brazil's various regions.

Also noteworthy is the fact that the most developed regions of Brazil (Regions 1, 2, and 3) exhibit model mortality levels that are consistently higher than those referring to the country as a whole (that is, actual child mortality in Rio de Janeiro, Sao Paulo, and the South is consistently lower than that at the national level). This outcome depends on the regional distribution of Brazil's population, which determines the weights that the regional estimates displayed in Tables 10 through 17 have on the national total. Table 18 presents the regional distribution of the population at two points in time: 1960 and 1970. Although some changes are noticeable between these two dates, the general picture emerging is similar in both instances: about 45 percent of Brazil's population inhabits Regions 1, 2, and 3, the most developed areas of the country, while about 30 percent inhabits the fairly backward Region 5 (the Northeast). Therefore, most of the positive influence

TABLE 18 Regional Distribution of the Population, 1960 and 1970: Brazil

	Enumerated Population		Percent of the Total	
Region	1960	1970	1960	1970
1	6,649,646	8,994,802	9.47	9.66
2	12,823,806	17,771,936	18.27	19.08
3	11,781,632	16,496,493	16.79	17.71
4	11,250,465	13,086,748	16.03	14.05
5	22,156,890	28,111,926	31.57	30.18
6	139,796	537,492	0.20	0.58
7	5,389,135	8,139,627	7.68	8.74
Total	70,191,370	93,139,024	100.01	100.00

exerted by the low child mortality observed in the first three regions is cancelled out by the negative one exerted by the less-developed Northeast. Hence, Brazil's overall levels fall between these two extremes.

The child mortality estimates presented in Tables 10 through 17 are accompanied by reference dates estimated by using Trussell's method (United Nations, 1983). According to these dates, the estimates derived from different sources (especially those corresponding to the PNAD surveys) often refer to overlapping time periods. Their consistency can therefore be assessed by making comparisons within regions.

Figures 4 through 11 display estimates of $_2q_0$, the probability of dying between birth and exact age 2, for the period 1935-75 for Brazil and each of its regions. The $_2q_0$ estimates obtained from any single source have been linked together. Once more, the $_xq_0$ estimates yielded by the estimation method used (Trussell's version of the one originally proposed by Brass and described in United Nations, 1983) have been translated into the corresponding $_2q_0$ estimates via the "South" model. Therefore, for any given data source, the most recent $_2q_0$ estimate is derived indirectly from data referring to women aged 20-24 at the time of interview, while those referring to earlier periods are derived from data corresponding to progressively older women.

In assessing the reliability of the estimates displayed in Figures 4 through 11, the possibility of two types of biases that frequently affect indirect child mortality estimates must be kept in mind. First, it is common for older women (40 and over) to underreport their number of children dead, a phenomenon that would bias downward the $_2q_0$ estimates referring to the earliest periods covered by any given data source. Second, the estimation method used assumes that child mortality levels are independent of age of mother at the time of the birth. However, in actual populations, higher-than-average child mortality is often observed among the offspring of younger women (15-24). Hence, data referring to women aged 20-24 often yield overestimates of child mortality.

Most of the estimates for Brazil as a whole (shown in Figure 4) indicate that the second type of bias is in operation, since almost universally their most recent points indicate a reversal of the downward trend implied by the rest. The only exception is the curve associated with the 1974 ENDEF Survey, which also happens to fall out of line with those derived from the other PNADs. With the exception of the ENDEF estimates and the ones associated with age groups 20-24, those corresponding to the 1960-75 period and derived from the 1970 census and from the PNADs are fairly consistent. The 1960-67 estimates derived from the 1972 and 1973 PNAD surveys suggest that those obtained from the 1970 census may be somewhat low, but the difference is quite small. It is also likely that the 1960-67 estimates derived from the reports of older women from the 1976 and 1977 PNADs may be slightly low.

Of greater importance is the discrepancy between the estimates derived from the 1950 and 1970 censuses and those obtained from the 1960 census. It is clear that, for Brazil as a whole, the latter fall below the general trend suggested by the former. A rapid examination of Figures 5 through 11 reveals that the same problem is evident at the regional level. This problem may arise either because mortality in childhood did not decline consistently or according to a roughly linear trend during the period being considered or because the 1960 census data on children ever born and surviving are deficient. Although the first possibility cannot be entirely discarded, the second one seems more likely and is, to a certain extent, validated by the possible problems in processing the 1960 census. Consider, for example, Figures 5 and 6 showing the series of $_2q_0$ estimates for Regions 1 and 2, respectively. The estimates derived from the 1960 data are not only lower than

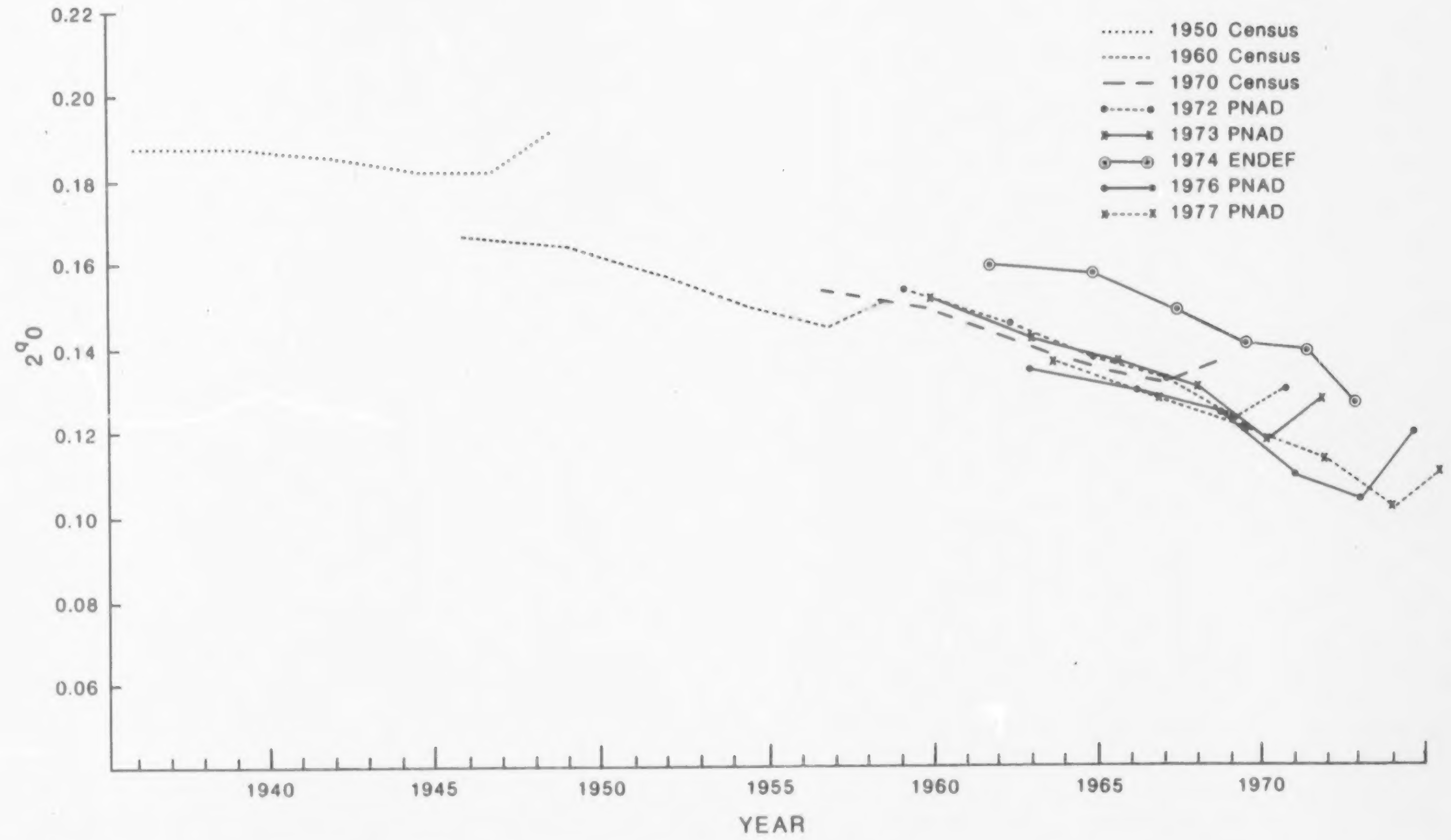


FIGURE 4 Estimates of $_2q_0$ for the Country as a Whole

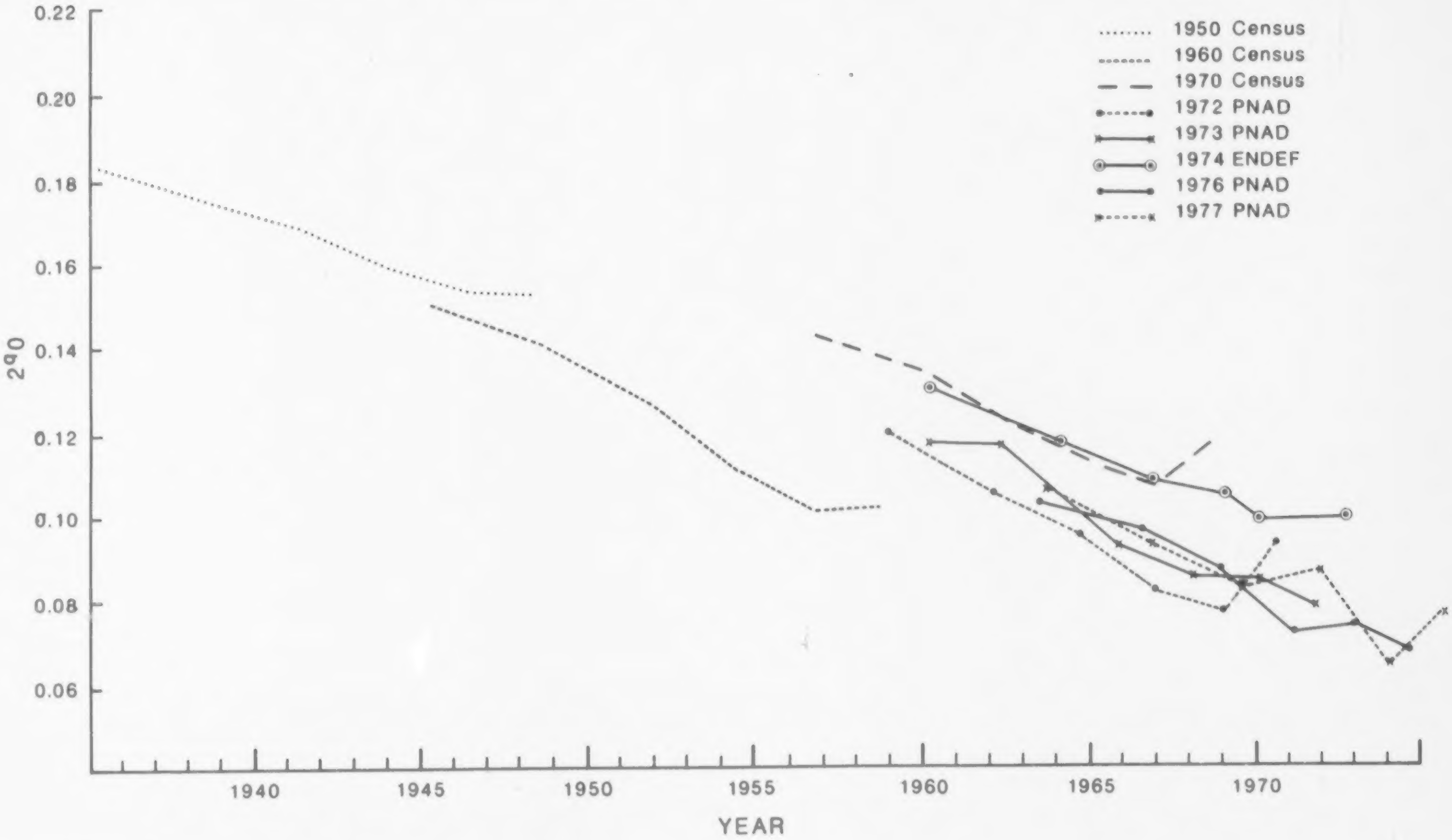


FIGURE 5 Estimates of $_2q_0$ for Region 1

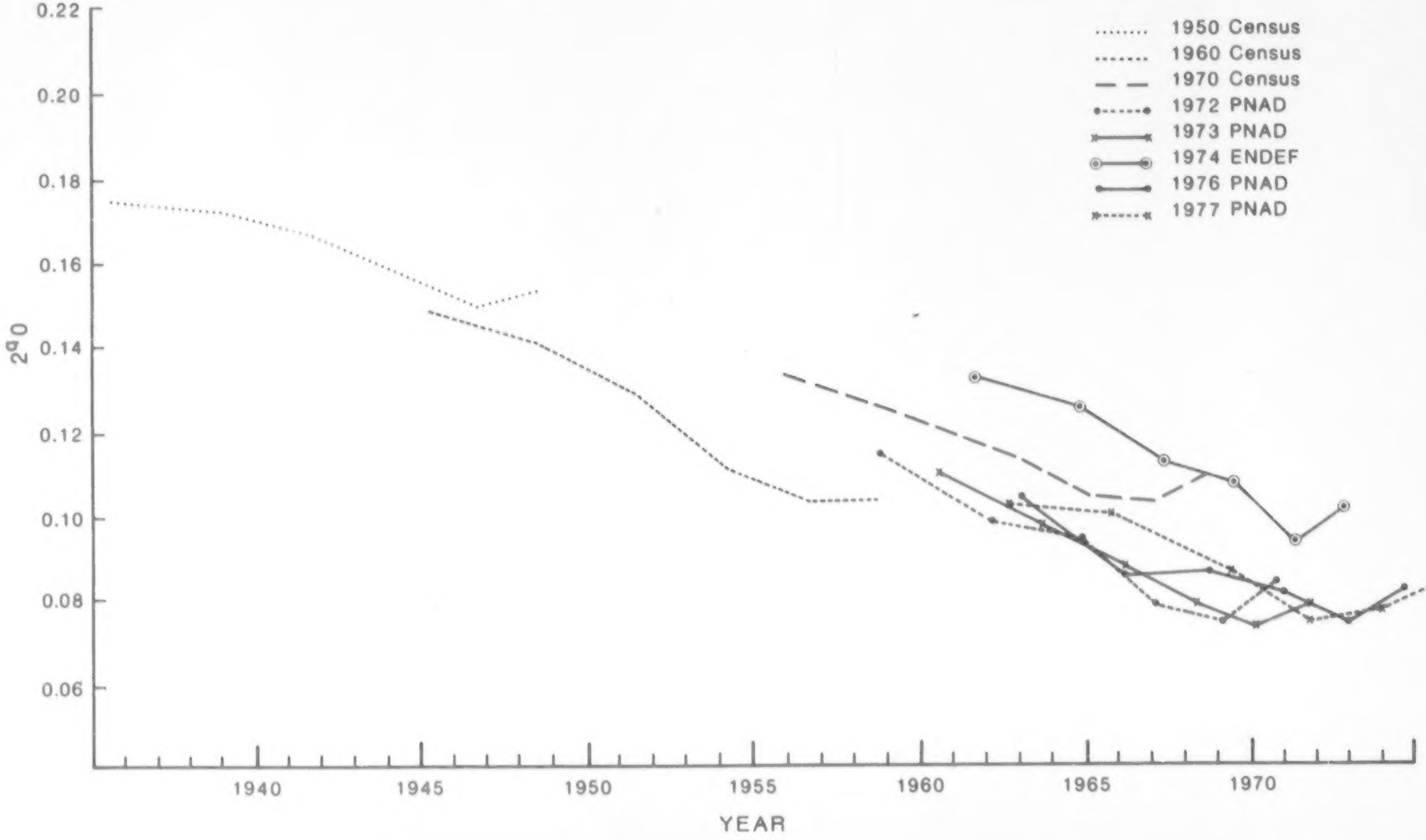


FIGURE 6 Estimates of $_2q_0$ for Region 2

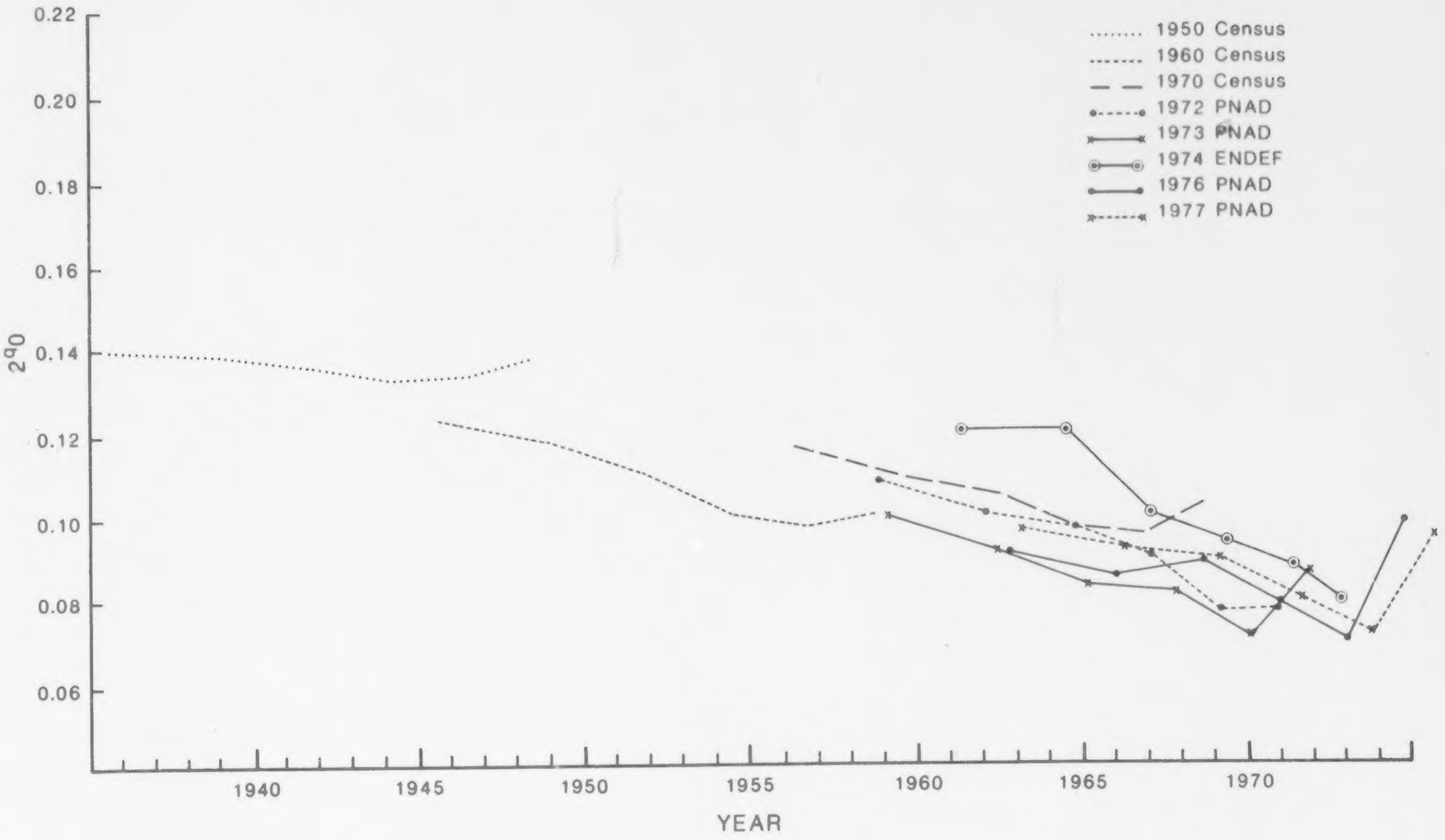


FIGURE 7 Estimates of $_2q_0$ for Region 3

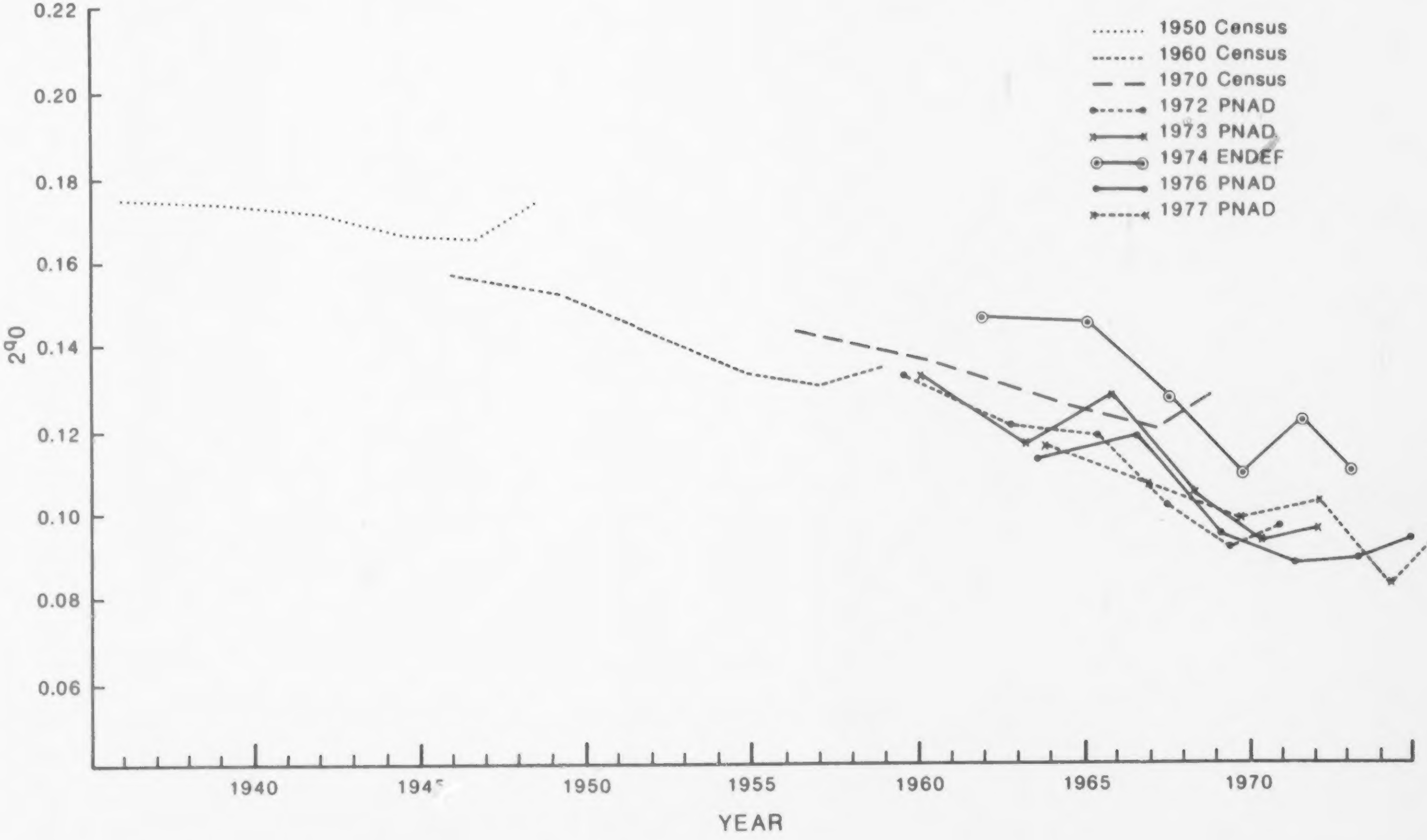


FIGURE 8 Estimates of $_2q_0$ for Region 4

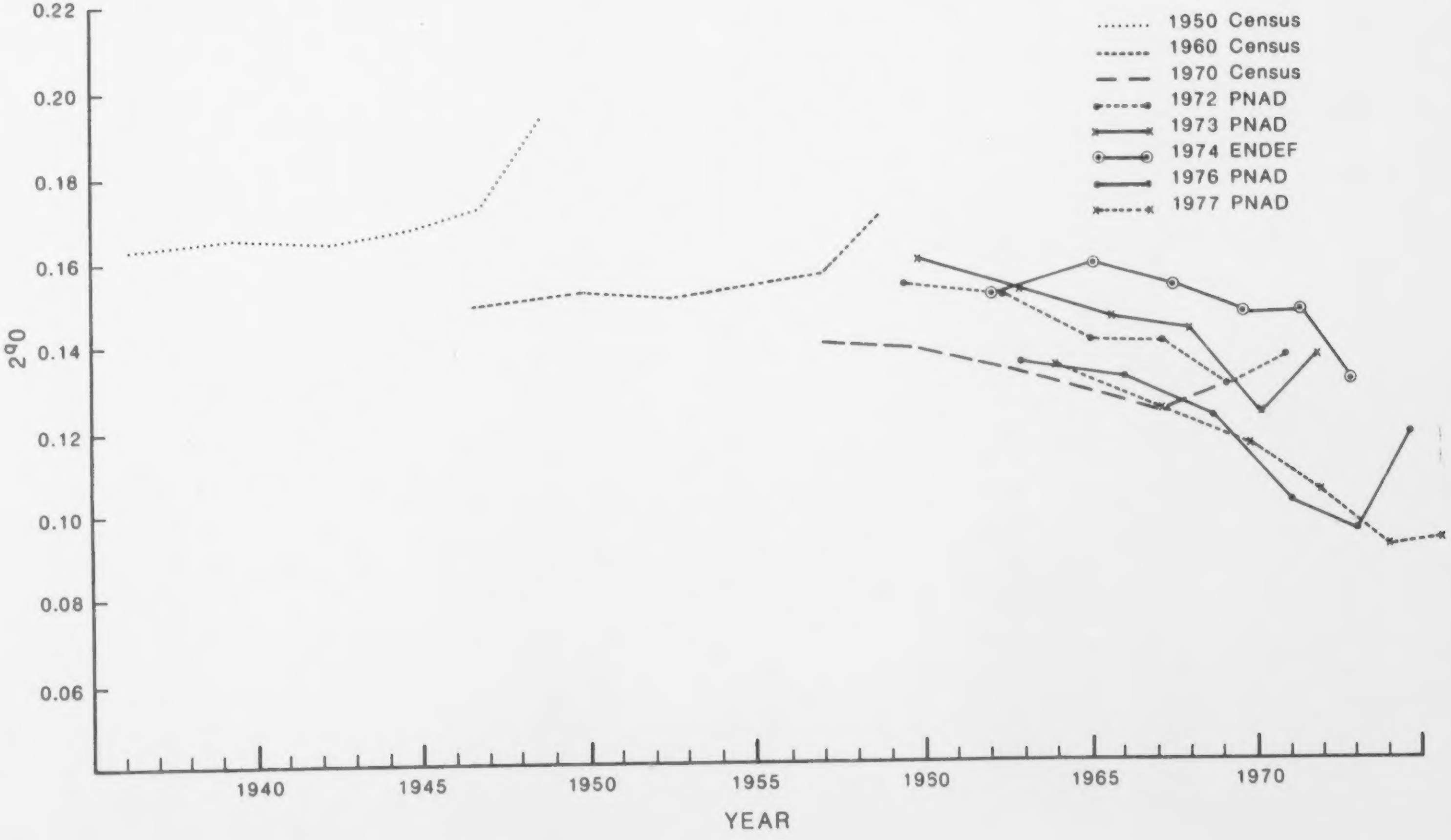


FIGURE 9 Estimates of $_2q_0$ for Region 5

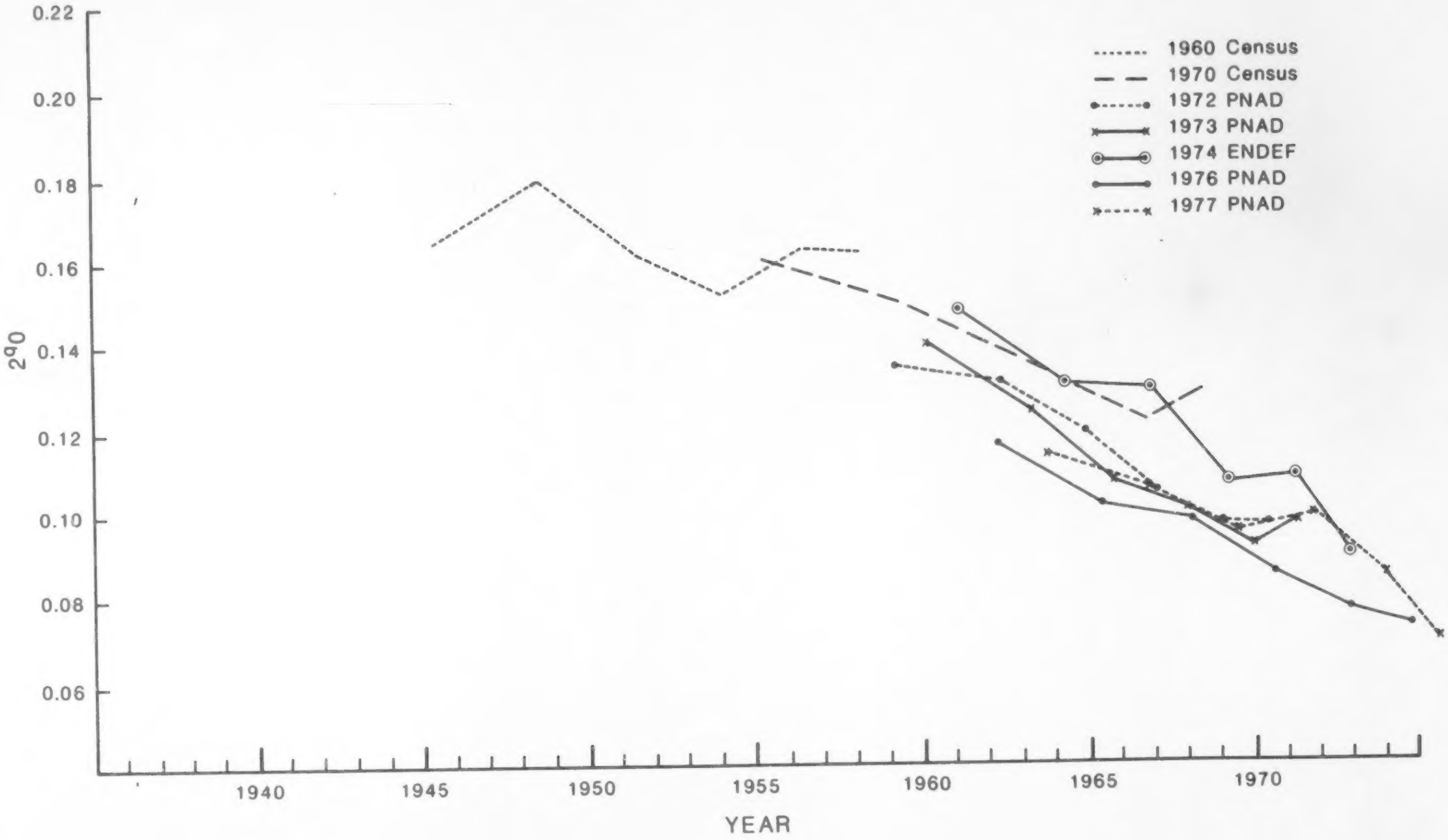


FIGURE 10 Estimates of $_2q_0$ for Region 6

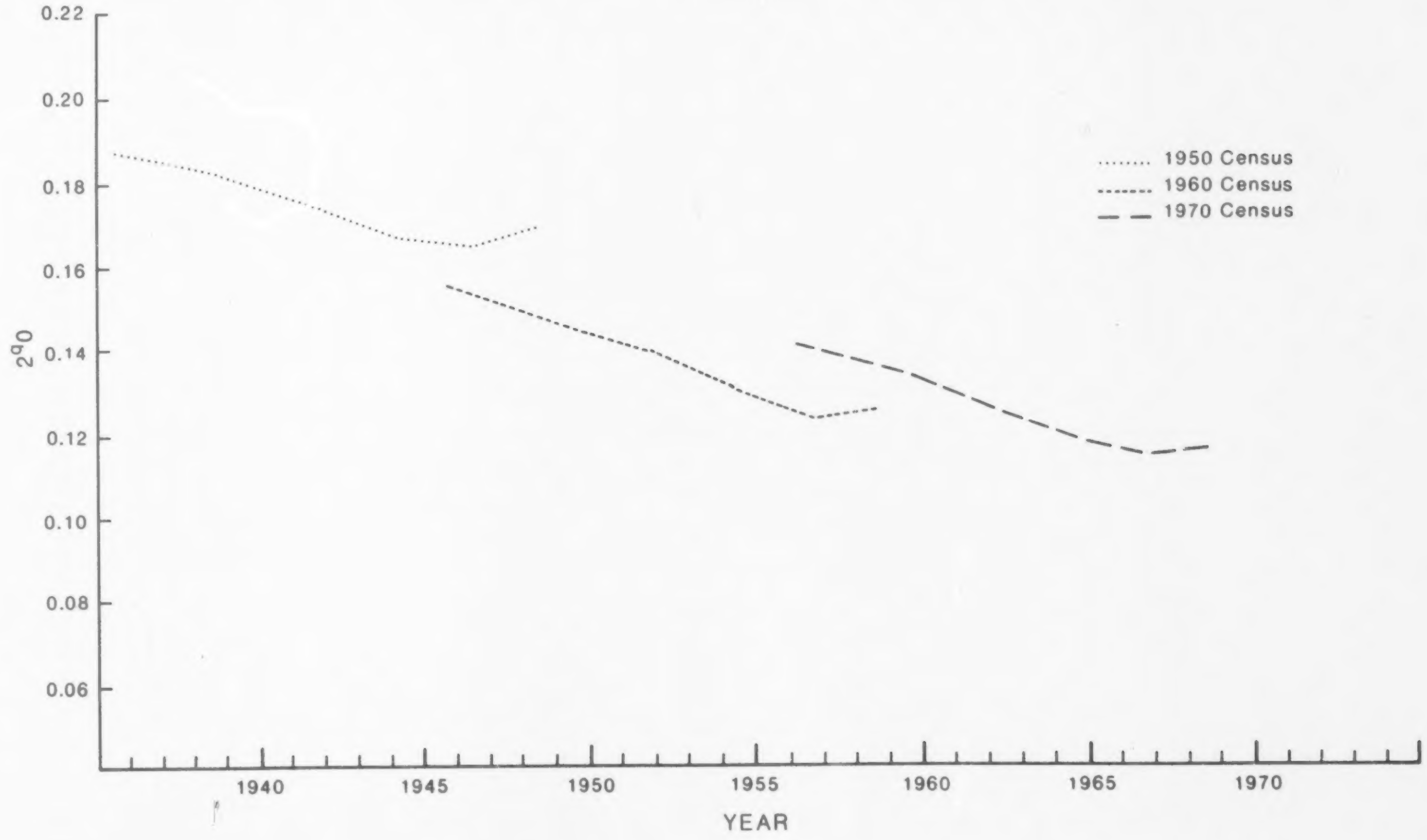


FIGURE 11 Estimates of $_2q_0$ for Region 7

the trend-line implied by those associated with the 1950 and 1970 censuses, they also refer, at the two extremes, to dates for which estimates obtained from other sources are available. For the earliest dates, estimates associated with the younger women in 1950 are directly comparable with those associated with older women in 1960. As mentioned above, the latter are likely to be too low, while the former, if associated with age groups 20-24, may be too high. Figures 5 and 6 show that the estimates based on the 1960 data fall below those based on the 1950 data, and that this relationship holds even when the 1950-based estimate considered is that derived from the information of women aged 25-29, which is usually not subject to an upward bias. For more recent dates, the 1960-based estimates derived from data referring to younger respondents may be compared with the 1970-based estimates corresponding to older women. This comparison seems to support the fact that the 1960-based estimates are deficient, since in spite of the upward bias they are likely to exhibit, they fall below the 1970-based estimates which are likely to be biased downward. The same type of observations can be made about the 1960-based estimates for most of the other regions and for Brazil as a whole, suggesting that, barring gross biases in the estimated reference dates, child mortality estimates derived from the 1960 census data should not be accepted.

Considering now the ${}_2q_0$ estimates at the regional level for the 1960-75 period (Figures 5 through 11), it is noticeable that the ones obtained from the 1974 ENDEF are generally higher than those obtained from the PNAD surveys. For most regions it is also true that the ENDEF estimates are higher than those derived from the 1970 census data, the two notable exceptions being Region 1 and, to a lesser extent, Region 6. The almost perfect coincidence between the ENDEF-based estimates for Region 1 (see Figure 5) and those obtained from the 1970 census suggests that either both data sources are equally flawed or that, if valid for Region 1, they cannot be rejected overall. It is not possible to establish beyond all reasonable doubt that the ENDEF overestimates mortality, but the general consistency observed between the estimates derived from the various PNAD surveys and, in most instances, between these and the ones obtained from the 1970 census does not warrant their rejection in favor of those derived from the ENDEF.

A Final Set of Child Mortality Estimates

A careful examination of the trends and relations exhibited by the different sets of estimates presented in Figures 4 to 11 led to the selection of a set of key levels representing child mortality at the regional and at the national level. Table 19 presents the selected levels in conjunction with their reference dates. They were selected so that the trend lines they define represent a reasonable compromise among those suggested by the detailed estimates derived from the different data sources available. In every instance, estimates derived from the 1960 census data were ignored, and in general the levels selected for more recent periods fall somewhere in between those suggested by the ENDEF and those derived from the other PNADs. In this sense, the estimates for more recent periods may be somewhat conservative, since they do not reflect the lowest possible values suggested by the PNADs.

Once a set of key levels was selected for each region and for the country as a whole, linear interpolation was used to derive yearly estimates referring to January 1. Table 20 shows a summary of these estimates for the 1940-75 period at five-year intervals. For Region 6 (the Federal District of Brasilia) estimates are presented only for the 1960-75 period, since this region was not defined prior to 1960. For Region 7, the estimates referring to 1975, and even those referring to 1970, were obtained by extrapolating linearly the trend implied by the estimates derived from the 1970 census data. The data available for the urban areas of Region 7 from the two most recent PNADs (not shown) suggest that child mortality has declined steadily since 1970 and that the extrapolated level for 1975 (19.09) is acceptable.

It should be pointed out that most of the national estimates for the 1960-75 period are based on data that either exclude the whole of Region 7 (the 1972 and 1973 PNADs, and the 1974 ENDEF) or only its rural areas (the 1976 and 1977 PNADs). To the extent to which the population of the excluded areas is subject to mortality levels that differ from those of the rest of the population, the "whole country" estimates that do not incorporate their data will be biased. However, according to the 1970 census, the magnitude of this bias will be small because the population of Region 7 constitutes only about 10 percent of the country's total, and in terms of mortality levels of the Coale-Demeny tables its

TABLE 19 Set of Key Child Mortality Levels: Brazil

Region 1		Region 2		Region 3		Region 4	
Year	South Mortality Level	Year	South Mortality Level	Year	South Mortality Level	Year	South Mortality Level
1941.0	14.06	1941.8	14.23	1941.7	16.14	1941.9	14.02
1963.4	17.64	1962.6	17.83	1962.3	18.44	1960.1	16.22
1971.9	19.79	1974.6	20.18	1969.1	19.58	1967.1	17.37
						1972.1	18.54

Region 5		Region 6		Region 7		Whole Country	
Year	South Mortality Level	Year	South Mortality Level	Year	South Mortality Level	Year	South Mortality Level
1946.6	10.23	1956.2	14.67	1944.2	13.97	1944.3	13.12
1963.0	11.32	1965.0	17.53	1959.4	16.41	1959.2	14.90
1970.1	13.11	1974.0	19.97	1964.6	17.51	1964.9	16.04
				1966.7	17.83	1971.9	17.78

sign will be negative, since Region 7 exhibits mortality levels higher than those of the whole country (i.e., lower child mortality). Hence, if anything, the recent mortality estimates for Brazil as a whole derived from the PNAD data may slightly overestimate child mortality.

According to the final estimates of child mortality presented in Table 20, Brazil has experienced a steady decline in child mortality since 1940. This decline was somewhat slower prior to 1960 than since; in terms of infant mortality ($_1q_0$), the decline was about 16 percent between 1940 and 1960 and about 28 percent between 1960 and 1975. In total, infant mortality in Brazil declined by about 40 percent during the 1940-75 period. However, as stated earlier, this decline has not been equally distributed among all of Brazil's regions. Thus, while Regions 1 and 2 (Rio de Janeiro and Sao Paulo) exhibited an average decline of some 47 percent, Region 5 (the Northeast) saw its child mortality levels reduced by only 27 percent. The other large regions (3, 4, and 7) experienced declines comparable to those of the country as a whole.

It is interesting to note that infant mortality in Region 5 decreased by about the same amount during the first 15-year period considered (1940-65) as during the last 10-year period (1965-75). Therefore, some acceleration of the mortality decline is evident even in the most backward region of Brazil, an encouraging fact. In spite of these gains, however, much remains to be done. Out of every 100 births, some 12 children in the Northeastern Region still expect to die before age 1. The comparable figure for Sao Paulo and Rio is 7 per 100, still fairly high. Hence the corroboration of further reductions suggested by the most recent data will be welcome. For example, although initial estimation of mortality with 1980 census data gives results comparable to those estimated here, detailed analysis of those data is required to establish firm estimates.

ESTIMATING ADULT MORTALITY

In contrast with the wide availability of data for estimating child mortality in Brazil, the sparsity of data useful for estimating mortality in adult ages is striking. Direct information on the occurrence of deaths by age is available only for the 1960-64 period and for 1974-75. Information on maternal orphanhood is available

TABLE 20 Final Child Mortality Estimates, 1940-75: Brazil

Year	Region 1				Region 2			
	South Level	${}_{1}q_{0}$	${}_{5}q_{0}$	${}_{10}q_{0}$	South Level	${}_{1}q_{0}$	${}_{5}q_{0}$	${}_{10}q_{0}$
1940	13.90	.129	.205	.221	13.92	.129	.205	.220
1945	14.70	.121	.190	.203	14.78	.121	.188	.201
1950	15.50	.114	.174	.186	15.65	.112	.171	.183
1955	16.30	.107	.159	.170	16.51	.105	.155	.165
1960	17.10	.099	.145	.153	17.38	.097	.140	.148
1965	18.04	.091	.128	.135	18.30	.089	.123	.130
1970	19.31	.079	.105	.110	19.28	.079	.106	.111
1975	20.57	.067	.085	.089	20.26	.070	.090	.094

Year	Region 3				Region 4			
	South Level	${}_{1}q_{0}$	${}_{5}q_{0}$	${}_{10}q_{0}$	South Level	${}_{1}q_{0}$	${}_{5}q_{0}$	${}_{10}q_{0}$
1940	15.95	.110	.165	.177	13.79	.130	.208	.223
1945	16.51	.105	.155	.165	14.39	.124	.196	.210
1950	17.07	.100	.145	.154	15.00	.118	.184	.197
1955	17.62	.095	.135	.143	15.60	.113	.172	.184
1960	18.18	.090	.125	.132	16.21	.107	.161	.171
1965	18.89	.083	.112	.118	17.02	.100	.146	.155
1970	19.73	.075	.098	.103	18.05	.091	.128	.135
1975	20.57	.067	.085	.089	19.22	.080	.106	.112

TABLE 20 (continued)

	Region 5				Region 6			
Year	South Level	1%	5%	10%	South Level	1%	5%	10%
1940	9.79	.172	.297	.321	--	--	--	--
1945	10.12	.168	.289	.312	--	--	--	--
1950	10.46	.164	.281	.304	--	--	--	--
1955	10.79	.161	.273	.295	--	--	--	--
1960	11.12	.157	.266	.287	15.91	.110	.166	.178
1965	11.82	.150	.250	.269	17.53	.096	.137	.145
1970	13.08	.137	.222	.239	18.89	.083	.112	.118
1975	14.35	.125	.197	.211	20.24	.070	.090	.094

	Region 7				Whole Country			
Year	South Level	1%	5%	10%	South Level	1%	5%	10%
1940	13.30	.135	.218	.235	12.61	.142	.233	.251
1945	14.10	.127	.201	.216	13.20	.136	.220	.237
1950	14.90	.119	.186	.199	13.80	.130	.208	.223
1955	15.70	.112	.170	.182	14.40	.124	.196	.210
1960	16.51	.105	.155	.165	15.00	.119	.184	.197
1965	17.59	.095	.136	.144	16.06	.109	.163	.174
1970	18.33	.088	.122	.129	17.31	.098	.141	.149
1975	(19.09)	(.081)	(.108)	(.114)	18.55	.086	.118	.125

from the 1977 PNAD. Aside from these two sources of information, analysts have relied mostly on the information provided by age distributions and intercensal comparisons to derive estimates of mortality. The fact that censuses have been carried out at regular intervals during the past 40 years simplifies this task considerably, but it does not eliminate the problems usually encountered in comparing population counts that are subject to different types of errors. Of necessity, therefore, the estimates derived from this type of information are fairly weak and may be subject to considerable bias.

In this analysis, four types of methods have been used to estimate adult mortality levels in Brazil as a whole: the intercensal-comparisons method proposed by Preston (United Nations, 1983), stable and quasi-stable analysis (United Nations, 1967), methods based on the age distribution of deaths (United Nations, 1983), and those that allow the estimation of female adult mortality from information on maternal orphanhood (United Nations, 1983).

The first type of methods (intercensal comparisons) produce reasonable estimates of mortality only when the population under consideration is closed and when the completeness of coverage achieved by the two censuses being compared is similar. Stable analysis and the methods based on the age distribution of deaths assume that the population under consideration is stable. A certain relaxation of this hypothesis is achieved by the use of quasi-stable models in fitting the observed age distributions, but true quasi-stability demands that only mortality be changing. Changes in fertility, such as the ones that Brazil has experienced during at least the last decade, render the use of quasi-stable models inappropriate. Finally, estimation methods based on information about the orphanhood status of respondents produce acceptable estimates of mortality for periods ranging from 10 to 15 years prior to interview. Hence, the 1977 data are likely to yield reasonable mortality estimates for the 1962-67 period, but will have little to say about the recent past.

On the basis of these observations, several conclusions can be drawn. First, regional estimates cannot be obtained in a straightforward manner, because the regional populations are far from being closed and interregional migration makes both intercensal comparisons and the methods based on stable populations useless. If some correction for migration could be made, the exercise might be more fruitful, but the possibilities provided by the available data (corrections on the basis of place of birth, for example) demand considerable effort and will not in fact produce the desired statistic: that is, the creation of "closed" populations on the basis of place of birth will reveal mortality differentials by place of birth but _not_ by region of current residence, as would be desired. The same type of problem arises when data on orphanhood are considered. Classification of the orphanhood data by the respondent's region of residence at the time of the survey conveys no information about the place of residence of his or her parents. Hence, in a country like Brazil, where there is considerable interregional migration, the "regional" differentials, if any, displayed by this type of information cannot be construed as representing true differences between the various regions.

The second conclusion may be less obvious, but it is probably of greater importance. Taking into account the data sources and the various methods available, as well as the constraints in their use, it is clear that several sets of independent mortality estimates may be derived for approximately the 1945-65 period: intercensal estimates will cover 1945-65; stable and quasi-stable estimates will refer to 1940, 1950, and 1960; death distribution methods applied to the 1960 data will refer to 1960; and estimates derived from maternal orphanhood will cover the 1962-67 period. Hence, the likelihood of establishing with some degree of confidence the mortality levels to which the Brazilian population was subject during that period is high. The same, unfortunately, cannot be said about 1965-75, a period for which the main data sources are the 1970 age distribution and the 1974-75 data on death registration. Derivation of mortality estimates from either of these sources requires the use of methods based on stability or quasi-stability, and, as pointed out earlier, the Brazilian population has not been quasi-stable during the 1970-79 decade (due to a decline in fertility). Hence, there will be greater uncertainty about the levels of adult mortality estimated for the most recent past. This fact highlights the need for future surveys to emphasize the collection of data needed to estimate adult mortality.

The Preston Method of Intercensal Comparisons

Preston (United Nations, 1983) has proposed a method of estimating mortality beyond age 5 on the basis of the age and sex distribution of the population enumerated at two points in time. The essence of the method is to construct from observed population counts and from the age-specific growth rates they imply the equivalent of the $_5L_x$ function in a life table. From these $_5L_x$ estimates, the expectations of life at different ages can be calculated and compared to those of model life tables, thus exploring their consistency and plausibility.

In the case of Brazil the method was applied separately to each sex for each of the three intercensal periods: 1940-50, 1950-60, and 1960-70. Table 21 shows the results obtained, both in terms of e_x estimates (the expectation of life at age x) and in terms of the equivalent mortality levels in the "West" models of Coale and Demeny (1966). The "West" model was chosen because in most instances it minimized the range of variation of the mortality-level estimates obtained. As we shall see later, the 1960 data on registered deaths also suggest that "West" is the Coale-Demeny model that best approximates Brazilian adult mortality.

Examination of the results presented in Table 21 shows immediately that intercensal comparisons yield a fairly erratic set of estimates. For every intercensal period the range of the estimated mortality levels is never less than two and in several instances it reaches values greater than five. Deviant values seem more likely to occur at the two extremes of the age range, but even for the midrange the estimated levels are far from being smooth or constant. Their characteristics can be grasped more easily by referring to Figures 12 and 13 where they are displayed graphically.

For both males and females it is apparent that the rough shape of the intercensal estimates is maintained from one period to the next, although there are noticeable changes in the overall level of the different curves. In terms of this overall level it is important to note that the 1940-50 estimates are considerably lower (implying higher mortality) than those for the 1950-60 and 1960-70 periods. For females, a clear gradation in overall mortality levels is noticeable from the earliest to the latest period. For males, the near coincidence observed between the 1950-60 and 1960-70 estimates is

TABLE 21 Intercensal Estimates of Adult Mortality, 1940-70: Brazil

	1940-50		1950-60		1960-70	
Age x	e_x	West Mortality Level	e_x	West Mortality Level	e_x	West Mortality Level
Part A:	Females					
5	52.64	10.87	61.79	17.08	63.46	18.19
10	48.22	10.28	55.01	15.30	55.77	15.87
15	43.30	9.53	48.57	13.64	49.12	14.11
20	38.44	8.52	43.05	12.28	43.68	12.81
25	34.19	7.66	39.60	12.50	41.18	14.10
30	32.58	9.13	37.54	14.32	39.24	16.18
35	29.58	9.39	33.08	13.50	35.07	16.05
40	25.22	8.02	28.78	12.67	30.27	14.92
45	22.87	9.26	25.76	13.82	26.45	15.03
50	19.56	9.41	21.89	13.59	22.85	15.53
55	17.15	11.06	19.24	15.79	19.39	16.11
60	14.66	12.84	15.49	15.23	15.62	15.59
Part B:	Males					
5	49.32	9.95	59.29	17.27	59.90	17.72
10	45.19	9.54	53.00	15.70	53.25	15.90
15	42.50	10.61	49.22	16.28	48.89	16.00
20	40.07	11.83	45.89	17.14	44.70	16.06
25	35.60	11.04	42.02	17.42	41.59	17.00
30	32.69	11.71	38.67	18.35	38.50	18.17
35	29.05	11.65	33.54	17.34	33.90	17.77
40	24.16	9.81	28.63	16.19	28.82	16.47
45	20.90	9.68	24.80	16.26	24.44	15.62
50	17.69	9.44	20.90	15.91	21.01	16.14
55	15.39	10.70	18.03	17.41	17.68	16.55
60	12.91	11.70	14.13	15.67	14.11	15.58

suspect. According to the estimates corresponding to the middle age range (20 to 40), male mortality during the 1960-70 period seems to have been somewhat higher than during 1950-60. In addition, also according to the estimates corresponding to some middle age range (20 to 50, for example), females appear to be subject to higher mortality than males, since their levels are approximately two points lower than those displayed by males.

The ragged shapes displayed by the intercensal estimates are caused mainly by errors in age reporting. Their varying overall levels, however, are not only influenced by these errors, but also by the differential

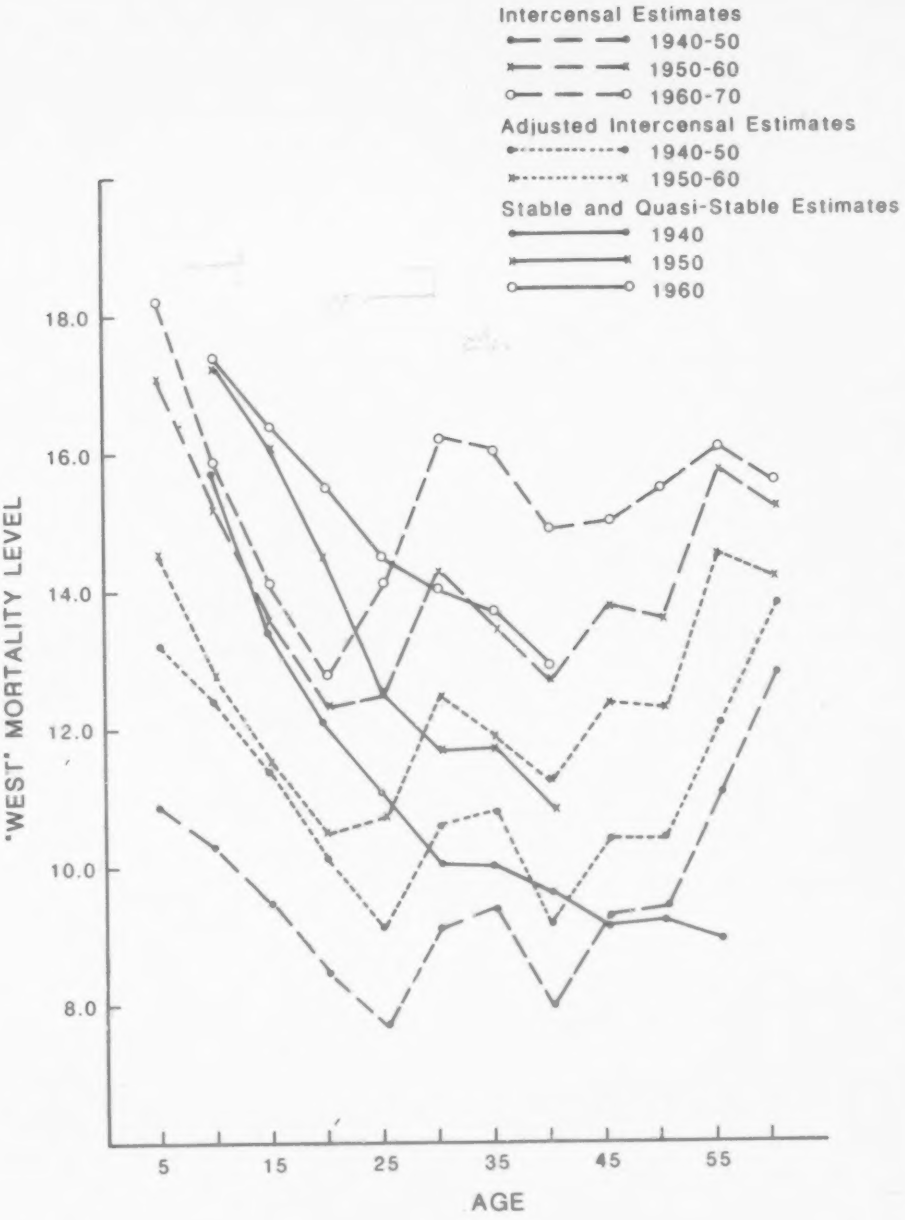


FIGURE 12 Estimated Levels of Adult Mortality Compared, 1940-65, Females: Brazil

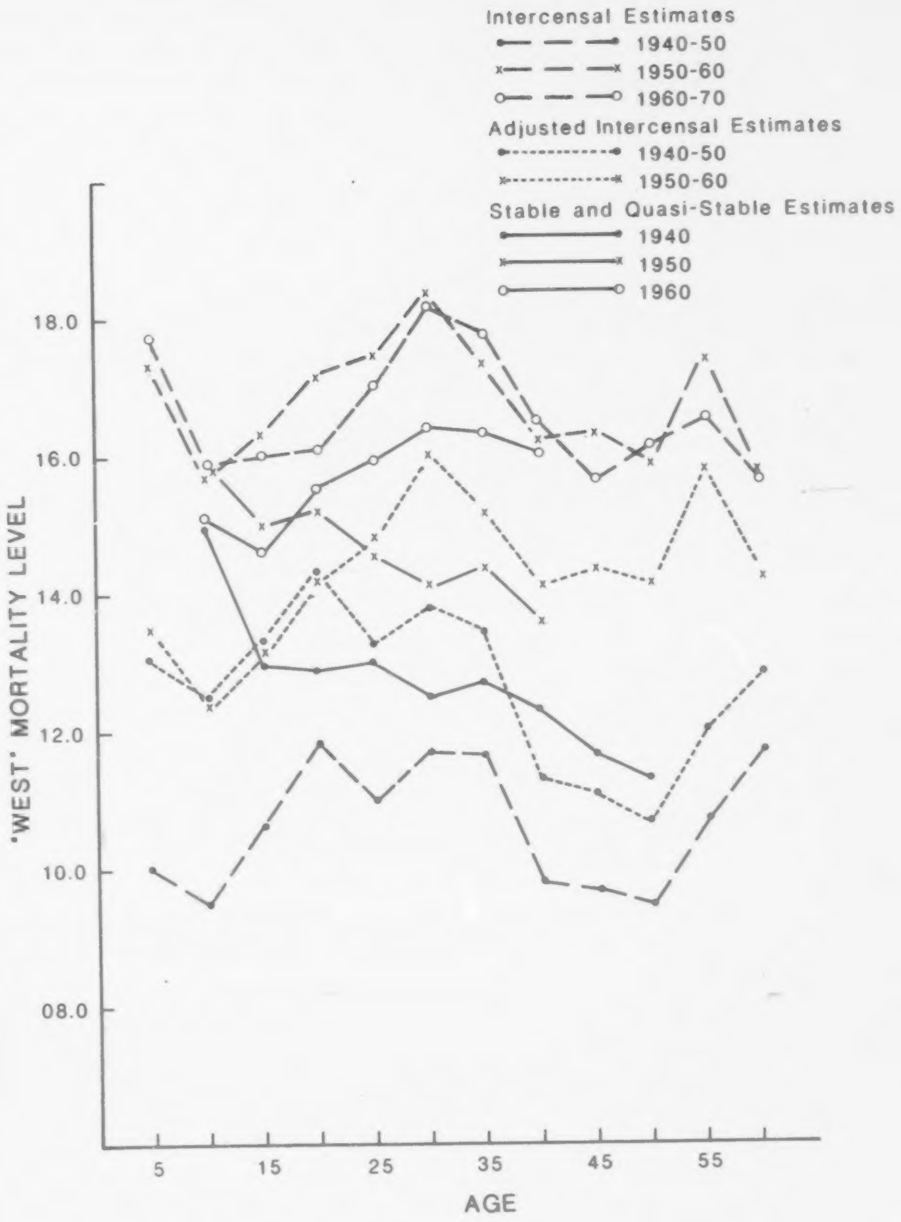


FIGURE 13 Estimated Levels of Adult Mortality Compared, 1940-65, Males: Brazil

degrees of coverage achieved by successive censuses or by the existence of net migration not properly accounted for during the application of the estimation procedure. Although the level of net migration to Brazil was not zero during the 1940-70 period, the evidence available suggests that it was very low.[1] Hence, to simplify the exposition, the biases detected in the overall levels of the intercensal estimates will be attributed mostly to differential census coverage. In particular, the observed trend in the estimates of male mortality, according to which its level increased from approximately 11.6 to 17.6 between the mid-1940s and the mid-1950s only to remain at about the same level or even decrease somewhat toward the mid-1960s, is more likely to be due to the lack of comparability of the census counts than to actual changes of mortality through time. Of course, the main premise underlying this argument is that mortality is more likely to have declined smoothly during the period considered than to have declined abruptly and then even increased at later dates. The second event is not impossible and, given the available evidence, it cannot be disproven. However, the relatively smooth trends displayed by the child mortality estimates presented in the previous section do not suggest that the population was subject to such unconventional changes in mortality levels.

On the other hand, there is no direct evidence concerning the degree of coverage achieved by the different censuses. Brazil has not conducted post-enumeration surveys of any kind, and the assessment of census coverage by analytical means is generally not feasible because of the lack of other reliable data that would allow independent estimation of fertility, mortality, and migration.

Hence, if one rejects the estimates yielded by the observed data as implausible, one's only alternative is to adjust the observed data on the basis of some reasonable assumption. To achieve this, consider the intercensal growth rates calculated directly from the observed data and presented in Table 5. The problems revealed so strikingly by the intercensal estimates are already evident in the trend followed by the intercensal growth rates during the 1940-70 period. Between 1940 and 1950 the growth rate for the country as a whole was 0.0235. It increased dramatically to 0.0295 during the 1950-60 intercensal period only to decrease somewhat during the next ten-year span (to 0.0283). The magnitudes of the increase and of the decline are more pronounced for males than for females, a fact that justifies, to a certain extent, the relatively greater inconsistencies observed in the male intercensal estimates (Figure 13). The anomalous patterns of growth observed could be easily explained by the fact that the 1950 census undercounted the population to a greater extent than its predecessor or its successors. Indeed, if the 1950 count were too low, the 1940-50 growth rate would be too low, the one for 1950-60 too high, and mortality would seem to have decreased sharply between the two periods. If the 1950 census is ignored and growth rates are calculated for the 1940-60 and 1940-70 periods (see Table 22), they show a plausible increase and fairly similar values for both sexes. Therefore, in order to adjust the apparently deficient 1950 data, the 1940-70 and 1960-70 growth rates were accepted as correct and, assuming a linear change in the growth rate during the 1940-70 period, adjusted growth rate values were calculated for each of the intercensal periods of interest (these are shown in Part B of Table 22).

Using the adjusted 1940-50 growth rates, the total 1950 census count was inflated by about 2.8 percent for males and 2.1 percent for females, the adjusted figures

TABLE 22 Observed and Adjusted Intercensal Growth Rates, 1940-70: Brazil

Intercensal Period	Male	Female
Part A: Observed Growth Rates (percent)		
1940-60	2.65	2.66
1940-70	2.70	2.73
1960-70	2.79	2.87
Part B: Adjusted Growth Rates (percent)		
1940-50	2.61	2.61
1950-60	2.70	2.74
1960-70	2.79	2.87

were redistributed according to the observed 1950 age distribution, and the Preston intercensal method was applied to the adjusted data. Table 23 shows the results obtained and Figures 12 and 13 present them graphically. The estimates of mortality level obtained from the adjusted data still display the ragged behavior they showed before adjustment, but, as expected, their overall levels are modified. For females the "adjusted" estimates imply levels, on average, two points higher for the 1940-50 period and about two points lower for the 1950-60 period than the corresponding ones obtained from the unadjusted data. For males the differences are of similar magnitudes and in identical directions, and they result in estimates whose overall levels seem less inconsistent than those associated with the unadjusted data. Unfortunately, without further analysis of the available data it is not possible at this stage to select a unique sequence of levels indicating the trend mortality has followed in Brazil during the 1940-70 period.

Stable and Quasi-Stable Analyses

If it were true that mortality and fertility had remained nearly constant in Brazil prior to 1940, that the impact of net migration on population growth and age structure were minor, and that the relatively smooth trends in mortality change assumed in the previous section had been operating during the 1940-70 period, the use of stable and quasi-stable methods to estimate mortality would be warranted. In fact, however, even the limited evidence available suggests that several of these requirements are not entirely satisfied. In particular, net immigration to Brazil was substantial up to 1900 and, even during the 1900-40 period, an annual net migration rate of some 0.002 seems to have prevailed (Merrick and Graham, 1979). It is also likely that mortality may have started to decline before 1940, and such decline need not necessarily have followed a smooth trend.

In spite of these observations, it is worthwhile to use stable and quasi-stable analysis to explore the consistency of the data available and to see whether the estimates obtained are, in fact, invalidated by actual deviations from stability.

Because estimation of adult mortality is the goal, stable and quasi-stable populations were fitted on the basis of observed age distributions and rates of natural

TABLE 23 Intercensal Estimates of Adult Mortality Derived from Adjusted Data, 1940-60: Brazil

Age x	1940-50 e_x	1940-50 West Mortality Level	1950-60 e_x	1950-60 West Mortality Level
Part A: Females				
5	56.15	13.22	57.90	14.46
10	51.21	12.41	51.78	12.83
15	45.78	11.40	45.91	11.50
20	40.47	10.15	40.84	10.46
25	35.87	9.13	37.70	10.76
30	34.07	10.61	35.89	12.46
35	30.78	10.75	31.77	11.89
40	26.17	9.23	27.72	11.25
45	23.64	10.43	24.92	12.38
50	20.15	10.43	21.24	12.34
55	17.64	12.06	18.72	14.57
60	15.01	13.85	15.13	14.20
Part B: Males				
5	53.67	12.99	54.41	13.54
10	48.91	12.36	48.91	12.36
15	45.77	13.25	45.64	13.14
20	42.87	14.33	42.79	14.25
25	37.87	13.18	39.38	14.75
30	34.61	13.76	36.47	15.94
35	30.55	13.44	31.82	15.15
40	25.30	11.32	27.28	14.11
45	21.80	11.06	23.75	14.34
50	18.37	10.69	20.10	14.12
55	15.94	11.98	17.40	15.83
60	13.31	12.84	13.71	14.21

TABLE 24 Adjusted Growth Rates (in percent) for Exact Dates, 1940-70: Brazil

Year	Male	Female
1940	2.57	2.55
1950	2.66	2.68
1960	2.75	2.81
1970	2.84	2.94

increase. Therefore, estimates of the latter are needed for the census dates. Assuming again that growth rates changed linearly between 1940 and 1970, the values presented in Table 24 were calculated from the adjusted growth rates presented in Table 22. Then model stable populations were fitted to the proportions under age x recorded by the 1940 census.

A question arises concerning the family of models to be used in this fitting process. As mentioned earlier, there are reasons to believe that child mortality patterns in Brazil are best represented by the "South" models of the Coale-Demeny set. However, the available evidence on adult mortality suggests that "West" is a better model of mortality over age 15. Therefore, in order to minimize biases introduced by the inadequacy of any single model, a new set of model stable populations was generated by combining models "South" and "West." Specifically, life tables that incorporate the "South" mortality pattern below age 15 and the "West" one thereafter were used to generate the required stable populations. In all cases a life table of a given "South" level was combined with one of the same level in model "West."

Table 25 presents the 1940 proportions under age x and the mortality levels associated with them. It is clear that from age 20 onward the levels associated with the female proportions under age x are consistently lower (by at least two levels in most cases) than those associated with the male proportions. The same type of differential was noticed in the intercensal estimates, and in both cases it may be ascribed to a relative excess of females

TABLE 25 Observed Proportions Under Age x for 1940 and Adult Mortality Estimates Derived by Fitting Stable Populations to the Observed Proportions Under Age x: Brazil

	Male		Female	
Age x	Proportion Under Age x	Mortality Level[a]	Proportion Under Age x	Mortality Level[a]
10	.3002	15.31	.2924	15.69
15	.4309	13.04	.4212	13.39
20	.5360	12.92	.5323	12.06
25	.6249	13.00	.6281	11.05
30	.7046	12.48	.7108	10.04
35	.7675	12.70	.7729	10.13
40	.8240	12.31	.8288	9.59
45	.8727	11.60	.8747	9.08
50	.9108	11.15	.9089	9.18
55	.9419	10.42	.9383	8.88

Note: r_f = .0255 and r_m = .0257.

[a] Within model stable populations generated by using South patterns of mortality for ages under 15 and West patterns over age 15.

at younger ages. The possibility of its being real is invalidated by evidence presented later.

Assuming that the changes in the growth rates presented in Table 24 are due mainly to changing mortality, the 1950 and 1960 populations would be quasi-stable and their mortality levels might be estimated by using the method described in Manual IV (United Nations, 1967). Using models derived from the "South-West" combination described above, the mortality levels associated with the proportions under age x observed in 1950 and 1960 were estimated (see Table 26). It is again apparent that the estimates associated with the proportions of females under age 20 and over are lower than the corresponding ones for males. That is, the age-misreporting pattern that is responsible for the sex differentials in mortality revealed by the 1940 census data is maintained in later censuses. Such patterns of age misreporting are fairly common in Latin America (United Nations, 1967) and usually preclude the use of the female age distribution for the estimation of adult mortality.

TABLE 26 Observed Proportions Under Age x, Adult Mortality Estimates Derived by Fitting Quasi-Stable Populations to the Observed Proportions Under Age x and Birth-Rate Equivalents, 1950 and 1960: Brazil

Age x	1950 Census Proportion Under Age x	1950 Census Mortality Level[a]	1950 Census Adjusted Birth Rate	1960 Census Proportion Under Age x	1960 Census Mortality Level[a]	1960 Census Adjusted Birth Rate
Part A: Females						
10	.2920	17.28	.0382	.2991	17.39	.0392
15	.4129	16.11	.0396	.4207	16.46	.0404
20	.5228	14.55	.0418	.5268	15.53	.0416
25	.6231	12.51	.0451	.6193	14.54	.0431
30	.7039	11.64	.0468	.6962	14.05	.0438
35	.7664	11.71	.0466	.7608	13.73	.0443
40	.8247	10.81	.0485	.8176	12.95	.0456
Part B: Males						
10	.3018	15.88	.0410	.3101	15.11	.0429
15	.4244	15.03	.0422	.4329	14.61	.0437
20	.5267	15.17	.0420	.5315	15.50	.0424
25	.6190	14.55	.0429	.6170	15.93	.0418
30	.6976	14.09	.0436	.6897	16.37	.0412
35	.7604	14.39	.0432	.7541	16.35	.0412
40	.8194	13.57	.0445	.8105	16.02	.0417

[a] Within model stable populations generated by using South patterns of mortality for ages under 15 and West patterns over age 15.

To assess the consistency of the estimates based on stable and quasi-stable models, their values were plotted in Figures 12 and 13 to facilitate their comparison with the intercensal estimates presented in the previous section. For females, the intercensal estimates display such a sharply declining trend below age 30 that comparisons between them and almost any other set of estimates would be inconclusive. Over age 30, however, the somewhat more acceptable trend of the stable and quasi-stable estimates allows some type of rough evaluation, the main results of which are as follows: the 1940 stable estimates appear to be consistent with the 1940-50 intercensal estimates derived from adjusted data; the fact that the 1940 stable estimates fall almost consistently above the 1940-50 intercensal estimates derived from the observed data suggests that the latter are inadequate. A similar observation can be made about the 1960 quasi-stable estimates and those for 1950-60 derived from unadjusted data. On the whole, the intercensal estimates derived from the adjusted 1950 data display a more satisfactory relationship with respect to the stable and quasi-stable estimates than do their counterparts derived from the observed data. This conclusion becomes stronger when the estimates for males are considered. In this case, the stable and quasi-stable estimates over age 15 display acceptable trends and are easier to compare with the intercensal estimates associated with ages 25 to 50, say. It is clear that the type of relationship expected (the 1940 estimates being lower than those for 1940-50, and so on) is displayed only by the adjusted 1940-50, 1950-60, and the unadjusted 1960-70 estimates. As compared with the stable and quasi-stable estimates, the 1940-50 and 1950-60 intercensal estimates derived from unadjusted data are inadequate.

These comparisons reveal that, on the whole, the stable and quasi-stable estimates are not completely invalidated by being derived from a population which does not meet strictly the requirements for stability. However, these conclusions are weaker than they may seem at first sight because both the adjusted intercensal estimates and the stable and quasi-stable set depend on the assumptions made about the evolution of the growth rate through time. On this basis, therefore, they would be expected to be fairly consistent among themselves. It is reassuring to find that the data for males display the expected consistency. In the case of females, however, although some consistency is apparent, it can be established only with great ambiguity. This observation suggests that the female estimates are more likely to be flawed.

Methods Based on the Age Distribution of Deaths

Brass (1975) was the first to propose a method that uses the enumerated population and the number of reported deaths, both classified by age, to estimate the completeness of death registration over age 5 and which, therefore, permits the construction of an adjusted life table for adult ages. More recently Preston et al. (1980) have proposed a method based on the same general principles that achieves a similar goal while providing further evidence about the quality and possible inconsistencies of the observed data. Both the Brass and the Preston methods assume that the population under consideration is stable and that the completeness of death registration with respect to the completeness of enumeration of the population does not vary with age. In addition, the Preston method requires that the rate of growth of the stable population be known.

In the case of Brazil, there are two data sets available that make it possible to apply this method. The first refers to 1960 and consists of the number of deaths registered during the year and the population enumerated by the 1960 census. The second is constituted by the number of registered deaths occurring in 1975 and requires that an adequate population be estimated for the period (since no census took place that year). Strictly speaking, only the first set is a truly adequate input for the methods mentioned above, since the Brazilian population in 1960 was closer to being stable than the one in 1975. However, lack of other data referring to the more recent periods impels us to apply these methods even for 1975, in order to assess roughly the quality of the data.

Estimates for 1960

Table 27 presents the completeness estimates obtained when the method proposed by Preston et al. is applied to the 1960 data (United Nations, 1983). The main principle underlying this method is that, in a stable population, the growth rate and the age distribution of deaths over age x can be used to estimate the population of exact age x (essentially, the growth rate is used to expand the

TABLE 27 Estimates of Death Registration Completeness for Different Truncation Ages by Sex, 1960: Brazil

	Truncation Age, Male			Truncation Age, Female		
Age x	70	60	50	70	60	50
0	.555	.570	.587	.516	.514	.514
5	.545	.559	.575	.503	.501	.500
10	.551	.566	.583	.504	.501	.499
15	.554	.570	.588	.505	.501	.498
20	.549	.566	.583	.507	.503	.499
25	.544	.560	.577	.513	.507	.502
30	.537	.552	.567	.516	.510	.503
35	.533	.548	.560	.520	.512	.501
40	.533	.549	.558	.533	.525	.512
45	.534	.551	.554	.542	.532	.510
50	.540	.562	--	.558	.549	--
55	.547	.583	--	.577	.582	--
60	.534	--	--	.574	--	--
65	.624	--	--	.681	--	--
Mean[a]	.542	.558	.572	.516	.510	.503

Note: $r_f = .0281$ and $r_m = .0275$.

[a] From age 5 to 45.

reported number of deaths over age x). The ratio of the estimated population to the one observed is then used as an indicator of the level of completeness of death recording. Whenever this level is more or less constant with respect to age and the growth rate is known, the ratios corresponding to populations of different ages should be the same. In practice, however, an accurate determination of the denominators of these ratios (the "observed" population of exact age x) is often impossible because of age-reporting errors at the time of enumeration. In order to minimize the effects of these errors it is recommended that both numerator and denominator be cumulated. Therefore, estimates of completeness are derived for each of the age groups from x to z, where z is the "truncation age."

The completeness estimates obtained by using this method may be biased by different types of errors affecting the input data. Two types of errors can be distinguished: those in the estimated growth rate and those present in the age distribution of either deaths or the observed population. Errors in the growth rate produce typical deviations of the completeness estimates from the horizontal line they should ideally follow. For instance, a growth rate that is too high will produce estimates that decrease steadily as age increases, and the opposite trend will be noticed if the growth rate is too low. In both cases, the increasing or decreasing trends will be almost linear with respect to age.

Exaggeration of the reported age at death will also produce estimates of completeness that increase with age. However, unless the tendency to exaggerate age at death starts very early, the pattern displayed by the completeness estimates will deviate noticeably from a straight line. Specifically, exaggeration of age at death beyond age y will produce estimates that are fairly constant up to age y and that increase substantially thereafter. In addition, if a new set of estimates is calculated by using y as truncation age, it will be almost constant and at a level lower than that implied by the flat portion of the estimates obtained when truncation was effected at an age greater than y.

Another type of age-reporting error that may produce a set of completeness estimates with a pattern similar to that observed when age at death is exaggerated is the shift of older persons to younger ages. For example, suppose that a certain proportion of those aged y to z declare themselves as belonging to age group x to y-1. Then, even if age at death is correctly reported and completeness of death registration is invariant with age, when the latter is estimated by truncating at age z, the completeness estimates over age y will appear to be too high and only those below age x will be correct. In this case, truncation at age y will produce completeness estimates that are correct up to age x and decline thereafter. Only truncation at age x will produce a set of horizontal and accurate completeness estimates.

Because no data set is entirely free from errors such as these, it is always important to calculate sets of completeness estimates with different truncation ages. Table 27 presents estimates for three truncation ages (50, 60, and 70) for the 1960 data. To assess their consistency, plots of each set are presented in Figure 14.

The patterns displayed by the estimates for males suggest that errors in the age distribution of the 1960 population are greater than any that may be affecting the age distribution of deaths. When the data are truncated at age 70, the very high completeness estimate obtained at age 65 is due mainly to an undercount of the popula-

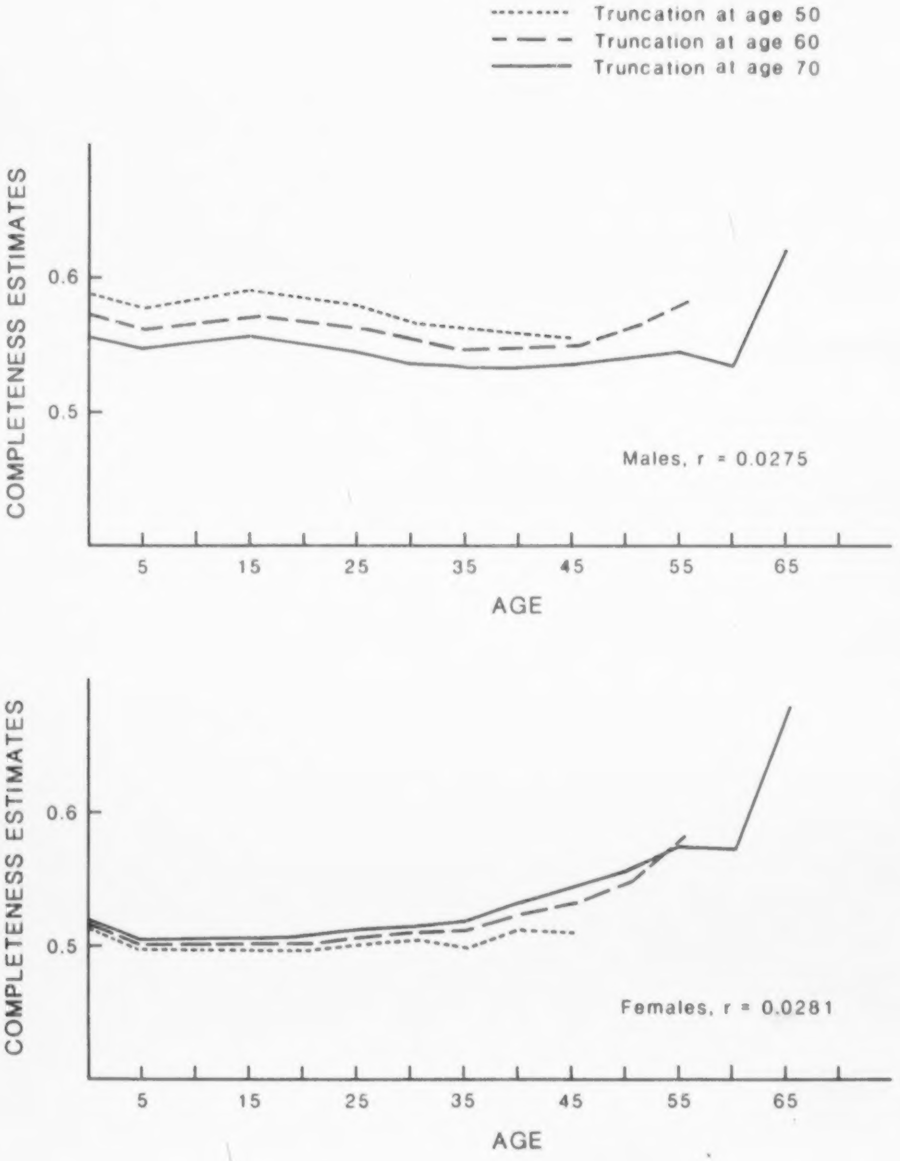


FIGURE 14 Estimates of the Completeness of Death Registration Relative to the 1960 Census Count: Brazil

tion aged 65-69. The deficit in this age group was probably shifted to younger ages, because the completeness estimates below age 60 are fairly similar. The same type of phenomenon seems to be affecting the estimates derived from data truncated at age 60. Those obtained by truncating at 50 display no obvious distortions of this type. In addition, the upward trend observed in the estimates above age 45 cannot be explained by exaggeration of age at death because the latter would result in lower mean completeness levels the younger the truncation age (see Table 27).

The increase of mean completeness levels with truncation age is unexpected and may be due to a variety of causes: a greater relative undercount of the population 0-49 than that affecting 0-59 or 0-69, net and increasing upward shifts of the population outside of these age groups, understatement of age at death for those dying above age 50, or biases introduced by the estimation procedure itself (the estimation of the population of exact age z, the truncation age, depends on the adequacy of the "West" model as a representation of the Brazilian experience). It is not possible to single out any one of these causes as the most likely. Fortunately, the differences in mean completeness are small (3 percent) and any estimate ranging between 54 and 57 percent would be adequate. The former was used to derive the adjusted age-specific mortality rates shown in Table 28.

The completeness estimates for females (see Figure 14) display a pattern consistent with both some degree of age misreporting, which causes substantial deficits in certain age groups (such as 65-69), and a certain degree of exaggeration of the age at death. The latter is substantiated by the fact that the mean completeness estimates between ages 5 and 45 decline with truncation age and by the shapes of the curves depicting the different sets of estimates: the one associated with truncation at age 50 is almost constant, while those associated with truncation ages 60 and 70 display sharp increases at the upper end of the age range. In this case, therefore, the estimates associated with truncation age 50 should be preferred. Hence, a completeness estimate of 50 percent was used in adjusting the central mortality rates presented in Table 28.

Before discussing the patterns displayed by these mortality rates it is important to note that the estimates presented in Figure 14 give no indication that the growth rates used in deriving them may be unacceptable. Valida-

TABLE 28 Adjusted Age-Specific Mortality Rates and Corresponding West Mortality Levels, by Sex, 1960: Brazil

	Male		Female	
Age x	$_5m_x$	West Mortality Level	$_5m_x$	West Mortality Level
5	.00207	17.79	.00228	16.84
10	.00165	17.45	.00129	18.29
15	.00225	18.42	.00199	18.17
20	.00363	17.58	.00330	17.06
25	.00470	16.24	.00435	16.25
30	.00563	15.88	.00542	15.69
35	.00719	15.46	.00674	15.05
40	.00891	15.72	.00788	14.89
45	.01229	15.16	.00959	14.72
50	.01627	15.68	.01260	15.17
Median Level		16.06		15.97

Note: Adjustment factor is 1.845 for males and 1.988 for females.

tion of the growth rate estimated for 1960 would, to a certain extent, validate the assumption made about the trends followed by the rate of growth during the 1940-70 period. In this respect the Brass growth balance equation (GBE) method can serve as a confirmatory tool because it allows the estimation of both the rate of growth and the completeness of death registration. Table 29 shows the estimates obtained by applying the GBE method. For males, the near coincidence of the GBE estimates ($r = 0.0272$ and $C = 0.535$) with those used or derived earlier ($r = 0.0271$ and $C = 0.542$) is very reassuring. For females, the growth rates are acceptably similar (0.0283 according to the GBE and 0.0281 according to our independent estimates) but the completeness estimates differ by a greater amount (about 4 percentage points). However, on the whole, these differences are minor and the generally good quality of the data at hand ought to be stressed.

As explained above, having selected estimates of death registration completeness for males and females (54.2 and 50.3 percent, respectively), their reciprocals were used

TABLE 29 Application of the Growth Balance Equation Method by Sex, 1960: Brazil

	Male		Female	
Age x	b(x+)	d(x+)	b(x+)	d(x+)
5	.0370	.0046	.0355[a]	.0039[a]
10	.0392	.0053	.0376	.0044
15	.0390	.0063	.0393	.0052
20	.0393	.0073	.0420	.0062
25	.0413	.0085	.0445	.0073
30	.0442	.0099	.0466	.0086
35	.0491	.0117	.0507	.0101
40	.0547	.0140	.0558	.0122
45	.0613	.0171	.0602	.0149
50	.0698[a]	.0211[a]	.0678	.0188
Growth Rate (percent)		2.72		2.83
Estimated Completeness (percent)		53.45		46.37

[a] Points excluded from the fitting process.

to adjust the observed age-specific mortality rates. The resulting adjusted rates and the mortality levels they imply in the "West" models are displayed in Table 28. The "West" model was selected because it is the one (within the four sets proposed by Coale and Demeny) that produces the least variable set of levels. However, as Table 28 shows, even the least variable set has a fairly wide range of variation. This outcome complicates the task of selecting one single level to represent mortality risks. To minimize the influence that undetected (or undetectable) outliers might have on this representative level, the median level was selected in each case: 16.06 for males and 15.97 for females. The similarity of these estimates casts doubts on the wide male-female mortality differential suggested by the intercensal or the stable and quasi-stable mortality estimates. This point will be discussed at greater length later.

Estimates for 1975

The application of the Preston et al. method to the 1975 data on death registration requires that estimates of the growth rate and of the population classified by sex and age be available for 1975. There are several ways of estimating the latter (using a growth rate to expand the 1970 population, using some preliminary estimate of mortality to project the 1970 population, etc.), but most of them depend on estimates that already incorporate some assumption about mortality and are, therefore, not very satisfactory. Fortunately, data on the age distribution of the Brazilian population around 1975 are not entirely lacking. In 1976, with the purpose of updating the 1970 sampling frame on which the PNAD samples were based, a complete listing of the population living in a sample of census tracks was undertaken. The results of this listing (1976 Listagem) for the PNAD regions are available and are presented in Table 30, together with the number of deaths registered in 1975 classified by sex. These data will be the input for the Preston et al. method.

TABLE 30 Estimated Population and Registered Deaths by Sex and Age, 1975: Brazil

Age Group	Male		Female	
	Population	Deaths	Population	Deaths
0-4	6,456,800	157,361	6,302,878	126,598
5-9	6,350,383	7,749	6,228,064	5,825
10-14	6,283,273	5,803	6,292,291	3,979
15-19	5,404,929	8,635	5,700,627	5,471
20-24	4,429,342	11,291	4,750,227	6,502
25-29	3,501,416	11,290	3,744,449	6,631
30-34	2,847,815	11,939	2,987,693	7,373
35-39	2,562,934	14,433	2,722,622	9,063
40-44	2,304,114	16,195	2,345,526	10,051
45-49	1,957,600	19,136	1,985,732	11,433
50-54	1,647,705	21,406	1,632,546	12,618
55-59	1,208,773	22,234	1,213,221	14,267
60-64	1,001,505	26,831	1,047,600	18,069
65-69	774,917	29,985	786,689	20,746
70+	954,680	85,737	1,133,176	82,613

Note: Source for estimated population is 1976 Listagem deflated to represent the population in the PNAD regions in mid-1975.

Preliminary results from the 1980 census suggest that Brazil's population grew at a rate of about 0.025 per annum between 1970 and 1980. This value contrasts with the 0.283 estimated for 1960-70. In addition, it was estimated earlier that by 1970 the female population was growing at a rate of 0.0294, while males were growing at a rate of 0.0284 (see Table 24). That is, in the absence of a fertility decline, the growth rate by 1975 would have been substantially higher than the preliminary 1980 census results suggest.

In order to decide which of these growth rates to use in applying the Preston et al. method, we must recall that this method is based on the assumption of stability. When a quasi-stable population is considered, the growth rate at the time of enumeration is a satisfactory proxy for the stable growth rate required as input. But in cases where the birth rate has been declining, perhaps the best choice is the growth rate of the population 5 and over, or even 10 and over, depending on when fertility started to decline. In the case at hand, the growth rate estimates for 1970 were assumed to represent those of the population five and over in 1975, and were used as input in applying the method.

Table 31 shows the completeness estimates obtained by using different truncation ages, and Figure 15 displays plots of these estimates. It is immediately evident that the estimates oscillate with age, although in most cases the oscillations observed occur around a horizontal line (that is, the estimates neither increase nor decrease consistently with age). Such oscillating patterns are typical of destabilized populations, although their amplitude in the Brazilian case seems somewhat large. In no case do these curves suggest that the growth rate estimates used are inadequate. The slightly declining trend of the estimates for males derived by truncating at age 70 is more likely to be due to overestimation of the population aged 60-64 and 65-69 than to problems related to the growth rate.

As in the case of males in 1960, the mean completeness levels estimated for both males and females in 1975 increase as truncation age decreases. Several of the possible causes of this pattern have been mentioned above, but once more it is not possible to select one as the most likely. However, the completeness curves associated with truncation age 50 appear to be less distorted than the others and, in consequence, their means over age 5 will be adopted as completeness estimates.

TABLE 31 Estimates of Death Registration Completeness for Different Truncation Ages by Sex, 1975: Brazil

	Truncation Age, Male			Truncation Age, Female		
Age x	70	60	50	70	60	50
0	1.040	1.082	1.121	.882	.908	.931
5	1.001	1.041	1.077	.842	.866	.885
10	0.987	1.027	1.062	.823	.846	.862
15	0.999	1.041	1.079	.827	.850	.866
20	1.014	1.059	1.102	.843	.867	.884
25	1.021	1.071	1.120	.857	.884	.904
30	1.011	1.062	1.113	.859	.887	.906
35	0.985	1.034	1.079	.845	.871	.883
40	0.965	1.014	1.049	.844	.870	.875
45	0.959	1.010	1.038	.848	.876	.871
50	0.957	1.015	--	.858	.895	--
55	0.969	1.069	--	.873	.945	--
60	0.932	--	--	.846	--	--
65	0.901	--	--	.853	--	--
Mean[a]	0.994	1.040	1.080	.843	.869	.882

Note: $r_m = .0284$ and $r_f = .0294$.

[a] For ages 5 to 45.

These estimates (1.08 percent for males and 0.88 percent for females) may seem, at first sight, fairly high. One must recall, however, that the Listagem figures refer only to the population in the PNAD regions, that is, they exclude all the inhabitants of rural Region 7 (approximately 5 percent of the Brazilian population), and that they do not result from the total enumeration of the population. Therefore, their overall magnitude may not be correct (specifically, it is likely to be too low). However, even if this fact is taken into account, the estimates adopted indicate that there is a substantial differential in the completeness of death registration by sex (a differential that was fairly small in 1960) and that for males the absolute level of completeness of death registration is likely to be higher than 90 percent. In other words, the registration of male deaths appears to have been remarkably complete in 1975.

Using the adjustment factors implied by the estimated completeness levels, adjusted age-specific mortality rates were calculated. These rates and the levels they

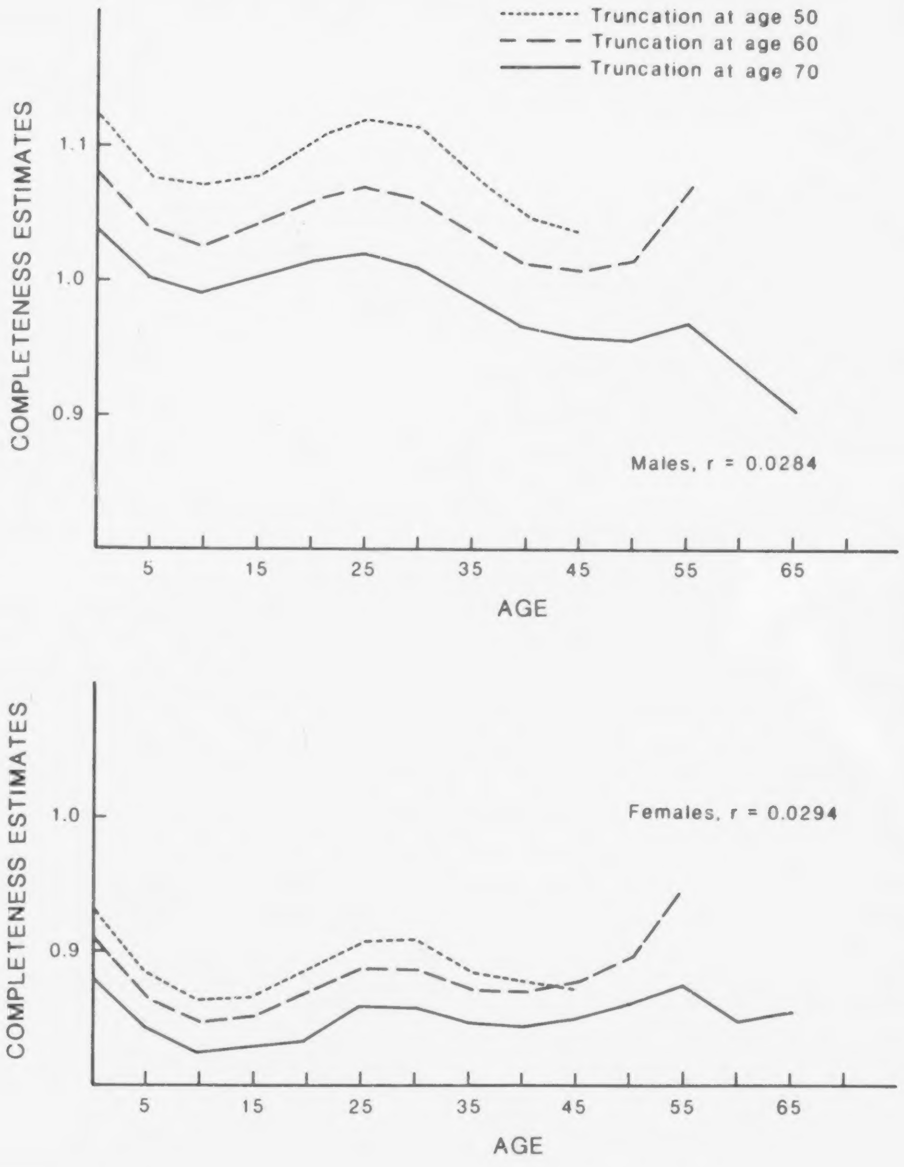


FIGURE 15 Estimates of the Completeness of Death Registration in 1975 Relative to the 1976 Listagem: Brazil

TABLE 32 Adjusted Age-Specific Mortality Rates and Corresponding West Mortality Levels by Sex, 1975: Brazil

	Male		Female	
Age x	$_5m_x$	West Mortality Level	$_5m_x$	West Mortality Level
5	.00113	20.45	.00110	19.74
10	.00086	20.61	.00074	20.16
15	.00148	20.67	.00113	20.34
20	.00236	20.08	.00161	20.26
25	.00299	19.08	.00208	19.98
30	.00388	18.34	.00290	19.25
35	.00521	17.80	.00392	18.68
40	.00651	18.18	.00504	18.42
45	.00905	18.17	.00677	18.20
50	.01203	19.06	.00909	18.68
55	.01703	19.79	.01383	18.04
Median		19.08		19.25

Note: Adjustment factor is .926 for males and 1.176 for females.

imply in the "West" models are presented in Table 32. "West" was chosen because it minimizes the variability of the estimated levels. However, the latter still cover a fairly wide range of possibilities. As in the case of the 1960 data, representative levels were selected by calculating the median of each set. The resulting estimates, 19.08 for males and 19.25 for females, suggest yet again that sex differentials in mortality are not greater than those embodied by the models themselves. Furthermore, these levels do not appear to be inconsistent with those obtained for the same period on the basis of information on child mortality.

Estimates Based on Information on Maternal Orphanhood

The 1977 PNAD survey included a question about the survivorship status of each respondent's mother. The data resulting from it are available for six of the seven PNAD regions (Region 1 is missing) and they allow the estimation of female adult mortality via the method proposed by

TABLE 33 Estimation of Female Adult Mortality on the Basis of Data on Maternal Orphanhood: Brazil

	Number of Respondents[a]					
Age Group	With Mother Alive	With Mother Dead	Age N	$\frac{l(25+N)}{l(25)}$	West Mortality Level	Reference Date
15-19	10,569,477	624,040	20	.9394	19.58	1969.2
20-24	8,386,616	835,993	25	.9060	19.13	1967.6
25-29	6,309,334	1,080,830	30	.8530	18.35	1965.8
30-34	4,547,572	1,284,277	35	.7817	17.66	1965.2
35-39	3,626,397	1,581,893	40	.6954	17.47	1964.4
40-44	2,536,577	1,862,013	45	.5682	16.88	1963.9
45-49	1,801,867	2,165,130	50	.4089	16.27	1962.6
50-54	1,493,720	3,967,214	--	--	--	--

Note: The mean age of mothers at the birth of their children is 27.26 years.

[a] Excluding Region 1.

Brass and Hill (1973). Table 33 presents the basic data and the estimated probabilities of survivorship from age 25 to age 25 + N for N ranging from 20 to 50. So that the consistency of these survivorship probabilities can be assessed, they are accompanied by the "West" mortality levels they imply.

The set of estimated levels declines steadily as the age of respondent increases. Since the older the respondent, the earlier the time to which the estimates refer, a declining trend with age would be expected. However, a more stringent test of the consistency of these estimates is not possible without estimates of their reference dates. The procedure proposed by Brass and Bamgboye (1981) has been used to estimate these dates. They are also shown in Table 33 and imply that female adult mortality in Brazil (excluding Region 1) declined by about three levels in roughly 7 years. Such a rapid mortality decline is not substantiated by other evidence, and it suggests that at least some of the estimates derived from information on orphanhood may be biased. As we shall see later, those associated with respondents aged 15 to 29 are too low (that is, the mortality levels they imply in the model tables are too high).

This type of bias is often encountered in the estimates derived from data referring to younger respondents. It has traditionally been explained by the "adoption effect," which results from the tendency of respondents whose biological mother has died, but whose mother by adoption is alive, not to report themselves as orphans. This bias may also stem in part from the fact that younger respondents are more likely to live in the parental home in the company of their siblings. Therefore, a survey gathering information about every household member is likely to overrepresent the survivorship status of mothers whose offspring still live in the same household, and mother's survival may be highly correlated with this event. Whatever the cause, the l(25+N)/l(25) estimates for N ranging from 20 to 30 cannot be accepted.

Another aspect of the estimates based on orphanhood data that is open to question is their representativity. That is, to what extent does the exclusion of Region 1 bias the resulting estimates? The magnitude of this bias would be minimal if mortality levels among females of Region 1 were similar to those prevalent in the rest of the country. Validation of this proposition, as well as evidence regarding the regional variation of mortality according to the orphanhood data, can be obtained by comparing the mortality levels implied by the survivorship probabilities estimated on the basis of the orphanhood data classified by region. Table 34 shows two levels for each region, the first representing a rough estimate for 1963 and the second being one for 1965. The corresponding values for Brazil without Region 1 are displayed under the label "weighted average." According to Table 34 the estimated levels for Region 2 are very similar to those of the "weighted average." Since Region 1 is expected to display levels comparable to those of Region 2, the similarity just noted implies that the "weighted average" is very likely to be similar to the true figure for Brazil as a whole. In the rest of this chapter, this assumption will be adopted as valid.

In principle, Table 34 also conveys some information about regional differentials in mortality. However, disregarding Region 7, the estimates display a fair degree of homogeneity (especially those for 1965) and, in general, the differentials they imply do not conform to those revealed by the child mortality estimates. For example, Region 5 does not appear to be subject to particularly high mortality, nor does Region 3 display very low mortality levels. These surprising outcomes are due to the very nature of the information on orphanhood: the data used as input have been classified by place of residence of respondent and not by mother's place of residence. Therefore, because the levels of inter-

TABLE 34 Regional Differentials in Female Adult Mortality as Estimated from Data on Maternal Orphanhood: Brazil

	West Mortality Level	
Region	Around 1963[a]	Around 1965[b]
1	--	--
2	16.38	17.40
3	15.54	17.70
4	16.30	16.82
5	16.56	17.33
6	17.92	17.11
7[c]	19.24	19.41
Weighted Average	16.58	17.57

[a] Average of the levels implied by 1(70)/1(25) and 1(75/1(25).

[b] Average of the levels implied by 1(60)/1(25) and 1(65)/1(25).

[c] Urban areas only.

regional migration during the past 40 or 50 years have been substantial, the orphanhood data classified by respondent's region of residence cannot be expected to reflect adequately mortality differentials that depend on the region of residence of the respondent's mother. In consequence, the type of data available do not allow the estimation of mortality differentials by region.

Comparison and Assessment of the Adult Mortality Estimates

Having presented the mortality estimates derived from different sources and through a variety of estimation methods, it is now possible to compare and evaluate them. Consider first the estimates derived by intercensal comparisons and stable or quasi-stable analysis. A preliminary comparison of the two sets has already been carried out earlier (see Figures 12 and 13), where it was noted that both the intercensal estimates and those derived by fitting stable or quasi-stable populations display a fairly wide range of variation. It was also established that the intercensal estimates based on the adjusted 1950 data are to be preferred over those derived from the observed census counts. However, no definite set of estimates representing the evolution of mortality during the 1940-60 period was selected. To perform this selection, consider the estimates as displayed in Figures 12 and 13. It is clear that with sets of estimates spanning a range of three or four levels in most instances, some degree of arbitrariness will have to be exercised in selecting "the most representative" of each set. Two main guidelines were adopted in selecting the representative estimates: first, that estimates near the two extremes of the age range used in each case (except, possibly, the quasi-stable estimates near the upper end) are more likely to be biased; and, second, because on the basis of the child mortality estimates mortality seems to have been declining steadily during the 1940-60 period, the representative estimates selected should, if possible, be consistent with the existence of this decline.

In the case of females, if the estimates associated with ages 15 or younger are disregarded, selecting a set that shows a steady decline with time narrows the possibilities considerably. We have decided to adopt those associated with age 30 in every case (selection of the stable and quasi-stable estimates associated with age 35 would modify the selected set only slightly). For males, whose sets of estimates usually span more narrow ranges, the ones selected were the average of those associated with ages 25, 30, and 35. Table 35 shows the selected sets by sex and it also presents the estimates derived from the death registration data.

To facilitate comparisons, the estimates in Table 35, together with those obtained from information on maternal orphanhood, have been plotted in Figure 16. It is immediately evident that the male intercensal and stable or quasi-stable estimates are consistent both with those obtained from death registration and with those derived from orphanhood information of older respondents, even though the latter refer only to female mortality. In contrast, the intercensal and stable estimates for females fall below those estimated from all other sources. The large discrepancy of the male-female mortality estimates derived from intercensal and stable analysis has already been noted and the possibility of it

TABLE 35 Selected Estimates of Adult Mortality by Sex in Terms of West Mortality Levels, 1940-75: Brazil

Type of Estimate and Reference Date	Male	Female
Stable and Quasi-Stable		
1940	12.73	10.04
1950	14.34	11.64
1960	16.22	14.05
Intercensal		
1940-50	13.46	10.69
1950-60	15.28	12.46
1960-70	17.65(17.20)[a]	16.18
Death Registration		
1960	16.06	15.97
1975	19.08	19.25

[a] The level in parenthesis is a "smoothed" value used in deriving the final mortality estimates.

being due mainly to greater distortions of the female age distributions relative to those affecting males has been advanced. Analysis of the reported age distributions via a method recently proposed by Coale (United Nations, 1983) suggests that this is indeed the case, and the patterns of age misreporting usually observed among Latin American females (United Nations, 1967) also support this possibility. Furthermore, evidence obtained from other sources (death registration and orphanhood data) does not suggest that the male-female mortality differentials in Brazil are greater than those embodied by the model life tables. Therefore, in deriving a final set of adult mortality estimates for Brazil as a whole, the intercensal and stable estimates for females were rejected, and it was assumed instead that, as suggested by the death registration data, adult mortality differentials by sex are adequately represented by the "West" models.

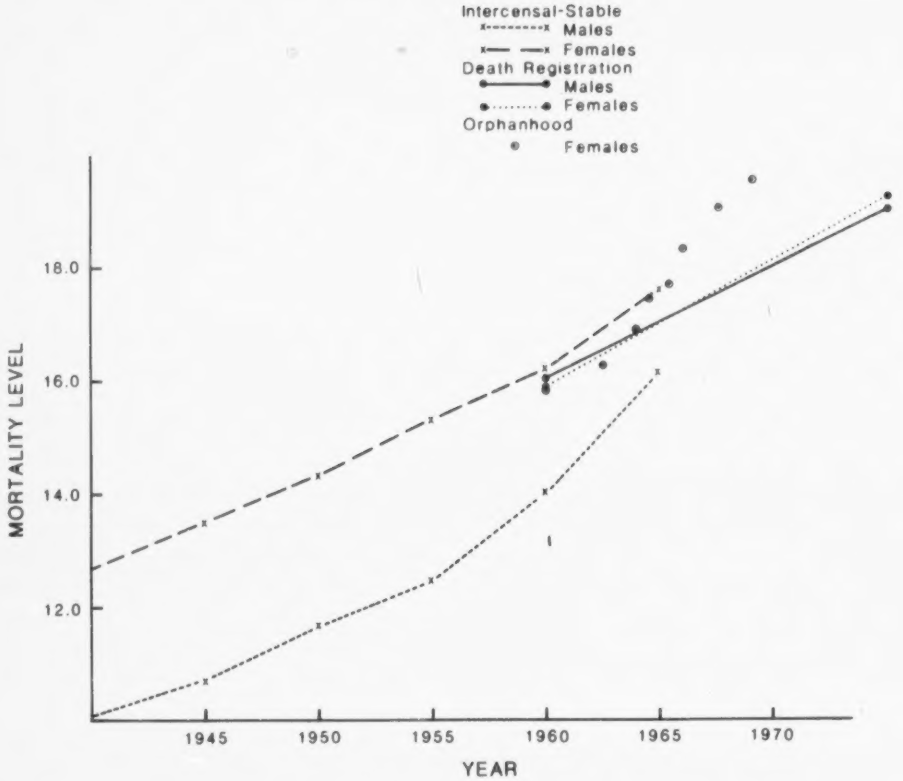


FIGURE 16 Selected Estimates of Adult Mortality, 1940-75: Brazil

A Final Set of Mortality Estimates for Brazil and Its Regions

Using the "West" mortality levels for males presented in Table 35 and assuming that the intercensal estimates refer to the middle of the intercensal period, linear interpolation by sections was used to derive estimates of the mortality levels prevalent during each year of the 1940-75 period. The corresponding "South" mortality levels derived from child mortality estimates were already available. Therefore, complete life tables by single-year periods could be calculated by splicing life tables for children (up to age 15) with the corresponding life tables for adults (over age 15). Table 36 presents estimates of the expectation of life at birth (e_0) and of the expectation of life at age 5 (e_5) obtained in

TABLE 36 Final Estimates of Adult Mortality in Terms of West Mortality Levels and Estimated Values of e_0 and e_5 by Sex, 1940-75: Brazil

Year	West Mortality Level	Male		Female	
		e_0	e_5	e_0	e_5
Part A: Whole Country					
1940	12.73	44.50	53.18	47.01	55.41
1945	13.46	46.01	54.18	48.57	56.44
1950	14.34	47.61	55.31	50.26	57.62
1955	15.28	49.25	56.48	52.06	58.93
1960	16.22	50.93	57.67	53.89	60.26
1965	17.20	53.32	59.05	56.46	61.78
1970	18.14	55.93	60.43	59.25	63.29
1975	19.08	58.66	61.82	62.00	64.77
Part B: Regions					
Region 1					
1940	14.04	47.49	55.01	50.11	57.28
1945	14.98	49.41	56.23	52.21	58.66
1950	16.10	51.52	57.66	54.50	60.26
1955	17.30	53.74	59.22	56.90	61.96
1960	18.49	56.01	60.81	59.34	63.69
1965	19.33	58.15	62.02	61.61	64.99
1970	20.24	60.98	63.39	64.34	66.43
1975	21.16	63.60	64.76	67.07	67.93
Region 2					
1940	14.06	47.54	55.04	50.16	57.31
1945	15.07	49.61	56.34	52.42	58.79
1950	16.26	51.87	57.88	54.88	60.50
1955	17.53	54.26	59.54	57.46	62.31
1960	18.80	56.70	61.23	60.08	64.15
1965	19.60	58.83	62.41	62.26	65.39
1970	20.21	60.90	63.34	64.26	66.38
1975	20.84	62.82	64.27	66.26	67.41
Region 3					
1940	16.11	52.14	57.78	55.16	60.39
1945	16.83	53.57	58.73	56.71	61.43
1950	17.73	55.21	59.91	58.47	62.72
1955	18.71	56.93	61.18	60.32	64.09
1960	19.67	58.72	62.46	62.18	65.46
1965	20.23	60.42	63.31	63.80	66.35
1970	20.68	61.99	64.00	65.41	67.11
1975	21.16	63.59	64.75	67.06	67.93

TABLE 36 (continued)

		Male		Female	
Year	West Mortality Level	e_0	e_5	e_0	e_5
Region 4					
1940	13.93	47.24	54.86	49.85	57.12
1945	14.67	48.73	55.82	51.46	58.20
1950	15.59	50.37	56.97	53.26	59.48
1955	16.56	52.09	58.21	55.13	60.86
1960	17.53	53.84	59.47	57.03	62.24
1965	18.23	55.65	60.48	58.96	63.34
1970	18.92	57.72	61.52	61.15	64.46
1975	19.77	60.35	62.80	63.66	65.79
Region 5					
1940	9.89	37.90	48.93	39.99	50.86
1945	10.32	38.74	49.55	40.91	51.53
1950	10.86	39.69	50.30	41.92	52.33
1955	11.45	40.69	51.10	42.99	53.19
1960	12.03	41.68	51.88	44.04	54.02
1965	12.66	43.30	52.87	45.74	55.06
1970	13.71	46.05	54.43	48.61	56.67
1975	14.75	48.72	55.89	51.46	58.28
Region 6					
1940	--	--	--	--	--
1945	--	--	--	--	--
1950	--	--	--	--	--
1955	--	--	--	--	--
1960	17.20	53.11	59.01	56.24	61.74
1965	18.77	56.87	61.24	60.26	64.16
1970	19.79	59.93	62.77	63.27	65.76
1975	20.82	62.78	64.24	66.22	67.38
Region 7					
1940	13.43	46.11	54.17	48.68	56.43
1945	14.37	48.06	55.42	50.73	57.75
1950	15.48	50.14	56.83	53.01	59.33
1955	16.67	52.33	58.35	55.38	61.02
1960	17.85	54.56	59.91	57.80	62.72
1965	18.84	57.03	61.34	60.43	64.26
1970	19.21	58.47	61.94	61.86	64.90
1975	19.64	60.06	62.62	63.36	65.61

this way for selected years. The "West" mortality levels used in deriving the adult portion of each life table are also displayed. As stated above, the same levels were used for males and females. The corresponding levels for children can be found in Table 20. The Appendix presents abridged life tables for Brazil as a whole for the years 1940, 1950, 1960, 1970, and 1975.

No reliable evidence could be found regarding adult mortality differentials between regions. However, regional adult mortality estimates are needed in order to apply the own-children method (used to estimate fertility in the next section). Therefore, with this need in mind, regional life tables were generated by assuming that the regional differentials in child mortality already estimated (see Table 20) are good indicators of regional differentials in adult mortality. Working under this assumption, the adult mortality levels estimated for Brazil as a whole were prorated for each region according to the ratio of the regional estimate of child mortality to the corresponding one for the country as a whole. The resulting adult mortality estimates in terms of "West" levels are shown in Table 36, accompanied by the estimated e_0 and e_5 values by sex. Although most of the estimates obtained by this process seem acceptable, no claim can be made about their accuracy. The paucity of data allowing the estimation of regional mortality precludes the derivation of better estimates.

CONCLUSION

This chapter presents estimates of child and adult mortality for Brazil as a whole and for each of the PNAD regions. The estimation of child mortality by region was possible from data that do reflect regional differentials. In contrast, adult mortality by region could not be estimated from data reflecting such differentials and had to be extrapolated by reference to child mortality. Therefore, the regional estimates of adult mortality presented here are somewhat weak and should be interpreted with caution.

The estimates for the country as a whole (summarized in Tables 20 and 36) suggest that mortality declined by gaining about six mortality levels in 35 years. In terms of expectation of life at birth, this decline translates into a gain of approximately 14 years for males and 15 years for females, that is, e_0 increased at an annual rate of approximately 0.4 years during the 1940-75 period. The gains have been equally impressive above age 5 as below age 5, but they still leave Brazil with an expectation of life in 1975 of about 60 years, suggesting that there is room for further improvement.

The mortality differentials by region revealed by the data on child mortality indicate that about 30 percent of Brazil's population (the inhabitants of Region 5, the Northeast) is still subject to very high mortality levels (implying an e_0 of only 50 years in 1975). If adult mortality is as high as the child mortality estimates suggest, the need for better health care and other related services is clear.

NOTE

1 According to census counts, the "foreign" population in Brazil (consisting of foreigners plus naturalized Brazilians) has evolved in the following manner: 1,407,000 in 1940; 1,214,000 in 1950; 1,400,000 in 1960; and 1,229,000 in 1970. By using estimates of mortality believed to be adequate for each intercensal period, it can be shown that the change in the foreign population between 1940 and 1950, and especially between 1960 and 1970, can be mostly be accounted for by mortality. For the 1950-60 period the expected number of foreigners obtained by projecting the 1950 figure to 1960 falls below the number enumerated in 1960 by some 361,000 persons (200,000 males and 161,000 females). This discrepancy may be due to an actual increase in the rate of net migration of foreigners to Brazil during the 1950-60 decade or to differential coverage of the foreign population by these censuses. However, even assuming that it is wholly due to net migration, the estimated excess number of foreigners in 1960 implies an annual immigration rate of only 0.0005, and this rate does not take into account the emigration of Brazilians, a flow that is considerably more difficult to measure. To give some idea of its magnitude we note that according to the 1960 round of censuses there were approximately 62,400 Brazilians living abroad (in Argentina, Colombia, Venezuela, Chile, Portugal, the United Kingdom, and West Germany. The 1960 tabulations for the United States and Canada do not distinguish Brazilians from other nationalities). By 1970, according to the censuses of countries that list Brazilians as a separate category (Argentina, Chile, Venezuela, the United States, and Canada), the number abroad was at least 77,500.

CHAPTER 3

FERTILITY

ESTIMATING FERTILITY

All the sources of demographic data in Brazil contain information about the fertility of its population. Every census since 1940 has included a question on children ever born, but only the two most recent ones (1970 and 1980) have also included questions on the occurrence of births during the year preceding the census (see Table 7). In addition, probabilistic samples of the households enumerated during the 1960 and 1970 censuses are available in machine-readable form, thus allowing detailed exploitation of the data. Questions on children ever born and on births during the year preceding interview have also been included in all the PNAD surveys, as well as in the ENDEF. Of these surveys, the one carried out in 1976 (being part of the PNAD series) is also available in machine-readable form. Finally, there is the vital registration system, which traditionally has recorded births as they occur. However, the lack of continuity in the data published by this system and the serious deficiencies evident in those which are available make them unsuitable as a basis for fertility estimation.

The types of data available determine the estimation methods that may be used. Data on children ever born gathered by censuses or surveys taken five or ten years apart have been used to estimate intercensal or intersurvey fertility rates. Because the change in average parity of a given group of women from one point in time to the next is directly related to the fertility rates prevalent during the intervening period, increments in the recorded average parity of women in the usual five-year age groups have been used to infer the fertility rates to which they have been subject (Arretx, 1973).

Problems arise, however, when the reported parities are affected by reporting errors. If, as is frequently the case, older women have a greater tendency to omit children ever born than do younger ones, the estimated parity increments will be too small and fertility will be underestimated. In the case of Brazil, the possibility of this error is aggravated by the fact that in the 1950 and 1960 censuses the question used to determine the number of children a woman had ever borne explicitly stated that stillbirths should be included in the count. As explained in the chapter on mortality, the raw data on this topic must be adjusted for the inclusion of stillbirths before any estimation method is applied. Under these circumstances, it is not surprising to find that the intercensal method of fertility estimation based solely on reported parities performs rather poorly for periods before 1970, and its results are not presented in this report.

Another method that has been fairly successful in estimating fertility in cases where its levels have remained more or less constant for some time is that proposed by Brass (1964). This method requires that two independent pieces of information on fertility be available: one referring to the long-term, cumulative experience of women subject to the risk of childbearing, and a second one referring to current fertility experience. The first is usually obtained from parity reports, while the second is derived from information about the occurrence of births during the year preceding interview ("births last year"). In the case of Brazil these two types of information are available from the 1970 census and from all the PNAD surveys. For earlier censuses, however, information on births that occurred during the year preceding the time of enumeration is missing. In those instances, the Brass procedure has been used to explore the consistency between reported parities (adjusted for the inclusion of stillbirths) and the shape of the "current" fertility schedules derived from the 1970 data. Such comparisons are enlightening and useful in establishing the level of fertility prevalent in Brazil before 1970.

Finally, the last method to be used in estimating fertility is the own-children method proposed by Cho (1973). The types of information it requires are the number of children (persons under 15) in the population, classified by single years of own age and single years of age of mother, and the total number of females aged 15 to 64, classified by single years of age. Such information usually can be derived from the data gathered by censuses or by demographic surveys, although the derivation is generally not straightforward. Problems arise because, although censuses and surveys always record the age of each member of the household, only rarely do they directly link each woman with her children when the children still live in the same household as she does. Information on the relationship of each household member to the head of the household usually makes it possible to establish with near certainty who the mother of each enumerated child is. This linking process is generally carried out by computer, and although it is not entirely foolproof, the results it yields are satisfactory. In addition, growing awareness of the importance of an accurate mother-child linkage has prompted the organizers of recent surveys to perform it directly in the field by posing the appropriate questions at the time of interview. In Brazil this procedure was followed in the 1976 PNAD, for which the "own-children" data can be obtained with relative ease. For previous years, the availability of machine-readable census samples for 1960 and 1970 makes possible the computer matching of mothers and children and the derivation of the data required for the application of this method.

The next two sections of this chapter, which present the results yielded by the two main methods of analysis used, are followed by a comparison of the preliminary estimates obtained. The concluding section presents the final set of estimates selected. Its implications in terms of population growth are presented in the concluding chapter.

The Brass Estimation Procedure

The Brass estimation procedure, also known as the P/F ratio method, is described in detail in UN Manual X (United Nations, 1982). It consists of comparing the lifetime cumulative fertility of women (as measured by the parities P they report at the time of interview) with the fertility that can be inferred from their most recent fertility experience (denoted by F and measured in terms of births occurring during the year preceding interview). If fertility had remained constant throughout their lifetimes and reporting were completely accurate, the two measures, the cumulative P and the current F, should be identical and all P/F ratios should equal one. In less ideal circumstances, even though fertility has been more or less constant but reporting is inaccurate, experience has shown that the typical reporting errors tend to have two main effects: they distort the level of current fertility but not its shape and they affect mostly the cumulative reports of older women rather than those of younger ones. These typical patterns of error justify Brass's suggestion of using the values of the P/F ratios observed among younger women (those aged 20-24, 25-29, and even 30-34) to adjust the level of current fertility and thus obtain a more accurate estimate.

The use of this method of adjustment is more difficult to justify in cases where fertility has not remained constant. In principle, the comparison of current and cumulated fertility is still valid, and indeed it can provide valuable insight about the changes fertility has undergone in the past, but when it is certain that fertility has changed no solid basis exists for selecting one adjustment factor over another. Nevertheless, in the analysis that follows, a series of adjustment factors will be selected and their acceptability will be assessed in later sections with reference to other evidence.

The 1950 and 1960 Censuses

Application of the Brass P/F ratio method to the 1950 and 1960 census data must be treated separately because, as explained above, these data are both incomplete and flawed. They are incomplete for the purposes of fertility estimation because no information is available on births occurring during the year preceding each census. They are flawed because the information on children ever born recorded by these two censuses includes stillbirths, that is, cases of children born dead which, in demography, are traditionally excluded from the definition of a woman's parity. This flaw is perhaps of greater relevance when the data are used to estimate child mortality than when they are used to estimate fertility. However, in both cases the bias inherent to the basic data cannot be ignored. The previous chapter described the procedure used to adjust the parity information derived from the 1950 and 1960 censuses (see discussion of Figure 3). The adjusted parities for Brazil and its seven regions from 1950 to 1977 are presented in Table 37.

Examination of the parities displayed in this table reveals several interesting traits of the basic data. For the country as a whole, average parities for older

TABLE 37 Reported Parities, 1950-77: Brazil and Regions

Age Group	Reported Parities 1950ᵃ	1960ᵃ	1970	1972	1973	1974	1976	1977
Part 1: Brazil								
15-19	0.14	0.12	0.12	0.12	0.11	0.11	0.12	0.11
20-24	1.06	1.07	0.97	0.93	0.91	0.84	0.82	0.84
25-29	2.43	2.47	2.43	2.38	2.27	2.26	2.04	2.02
30-34	3.74	3.69	3.78	3.74	3.73	3.80	3.40	3.37
35-39	4.86	4.74	4.80	4.81	4.86	5.12	4.51	4.53
40-44	5.53	5.33	5.31	5.47	5.58	5.92	5.19	5.20
45-49	5.93	5.60	5.52	5.80	5.83	6.05	5.57	5.58
Part 2: Region 1								
15-19	0.12	0.09	0.09	0.11	0.10	0.10	0.10	0.09
20-24	0.84	0.87	0.73	0.73	0.70	0.66	0.62	0.64
25-29	1.81	1.92	1.85	1.79	1.77	1.62	1.59	1.55
30-34	2.68	2.75	2.86	2.84	2.70	2.91	2.56	2.52
35-39	3.42	3.32	3.58	3.59	3.65	3.70	3.19	3.25
40-44	3.97	3.69	3.91	3.85	3.99	4.26	3.80	3.62
45-49	4.37	3.88	3.98	4.06	4.19	4.47	3.82	3.84
Part 3: Region 2								
15-19	0.11	0.11	0.09	0.10	0.10	0.09	0.10	0.10
20-24	0.91	0.95	0.77	0.74	0.70	0.66	0.68	0.70
25-29	2.10	2.08	1.97	1.88	1.84	1.74	1.65	1.65
30-34	3.22	2.96	2.99	2.83	2.86	2.92	2.64	2.59
35-39	4.19	3.78	3.73	3.79	3.66	4.09	3.35	3.61
40-44	4.95	4.31	4.09	4.15	4.41	4.66	4.06	4.07
45-49	5.52	4.61	4.37	4.41	4.39	4.75	4.23	4.32
Part 4: Region 3								
15-19	0.15	0.12	0.13	0.11	0.10	0.10	0.10	0.10
20-24	1.07	1.10	1.02	0.95	0.93	0.85	0.81	0.85
25-29	2.39	2.49	2.45	2.39	2.19	2.27	2.00	1.97
30-34	3.67	3.67	3.76	3.68	3.63	3.61	3.28	3.33
35-39	4.78	4.71	4.75	4.78	4.80	4.86	4.42	4.36
40-44	5.52	5.38	5.30	5.49	5.37	5.69	4.99	5.22
45-49	5.96	5.65	5.54	5.73	5.79	5.98	5.64	5.64

TABLE 37 (continued)

Age Group	Reported Parities 1950[a]	1960[a]	1970	1972	1973	1974	1976	1977
Part 5: Region 4								
15-19	0.13	0.11	0.09	0.09	0.07	0.08	0.08	0.07
20-24	1.08	1.10	0.90	0.82	0.80	0.76	0.72	0.72
25-29	2.56	2.62	2.43	2.32	2.13	2.22	1.97	1.85
30-34	3.98	3.97	3.99	3.89	3.87	3.92	3.39	3.31
35-39	5.27	5.14	5.20	5.25	5.30	5.43	4.87	4.65
40-44	6.04	5.79	5.82	5.96	5.97	6.67	5.80	5.53
45-49	6.52	6.19	6.08	6.38	6.59	6.99	6.12	6.03
Part 6: Region 5								
15-19	0.15	0.13	0.13	0.16	0.14	0.16	0.15	0.15
20-24	1.14	1.11	1.11	1.15	1.15	1.07	1.06	1.06
25-29	2.67	2.73	2.80	2.95	2.85	2.89	2.57	2.61
30-34	4.21	4.32	4.46	4.73	4.78	4.90	4.39	4.37
35-39	5.46	5.57	5.76	5.95	6.08	6.36	5.79	5.85
40-44	6.09	6.19	6.44	6.98	7.14	7.39	6.58	6.67
45-49	6.42	6.45	6.61	7.40	7.32	7.34	7.17	7.14
Part 7: Region 6								
15-19	--	0.21	0.13	0.12	0.11	0.10	0.09	0.11
20-24	--	1.21	0.98	0.84	0.84	0.91	0.77	0.72
25-29	--	2.43	2.30	2.16	2.14	2.37	1.83	1.75
30-34	--	3.15	3.52	3.46	3.40	3.95	3.22	2.89
35-39	--	4.16	4.48	4.31	4.22	5.39	4.08	3.86
40-44	--	4.67	5.14	5.05	4.82	6.45	5.06	4.46
45-49	--	5.24	5.45	5.48	5.33	6.31	5.50	4.99
Part 8: Region 7								
15-19	0.21	0.17	0.18	--	--	--	--	--
20-24	1.27	1.30	1.26	--	--	--	--	--
25-29	2.69	2.84	2.91	--	--	--	--	--
30-34	3.92	4.17	4.40	--	--	--	--	--
35-39	4.97	5.22	5.57	--	--	--	--	--
40-44	5.49	5.74	6.11	--	--	--	--	--
45-49	5.78	5.97	6.23	--	--	--	--	--

TABLE 37 (continued)

	Reported Parities							
Age Group	1950[a]	1960[a]	1970	1972	1973	1974	1976	1977
Part 9: Region 7, Urban Areas								
15-19	0.15	--	0.12	--	0.11	--	0.15	0.16
20-24	0.98	--	0.98	--	0.98	--	0.91	0.98
25-29	2.14	--	2.50	--	2.39	--	2.25	2.28
30-34	3.22	--	4.02	--	3.95	--	3.68	3.63
35-39	4.14	--	5.11	--	5.06	--	4.83	4.73
40-44	4.62	--	5.68	--	5.62	--	5.50	5.51
45-49	4.91	--	5.79	--	6.43	--	5.75	5.79
Part 10: Region 7, Rural Areas								
15-19	0.23	--	0.24	--	--	--	--	--
20-24	1.41	--	1.53	--	--	--	--	--
25-29	2.93	--	3.26	--	--	--	--	--
30-34	4.25	--	4.75	--	--	--	--	--
35-39	5.37	--	6.00	--	--	--	--	--
40-44	5.92	--	6.54	--	--	--	--	--
45-49	6.23	--	6.64	--	--	--	--	--

--: not available.

[a] Parities have been adjusted for the inclusion of stillbirths.

women (35 and over) according to the 1960 census are very similar to those recorded by the 1970 census; the equivalent average parities for 1950 are consistently higher. In addition, parities for women over 40 recorded by the early PNADs (1972 and 1973) are even higher than those recorded by the 1970 census, in spite of the fact that these PNADs do not include the rural part of Region 7, which appears to have higher-than-average fertility levels. These observations suggest that the parities of older women (35 and over) tend to be underreported in the censuses and that the degree of underreporting did not remain constant from one census to the next. In particular, the parities of older women according to the 1960 and even the 1970 censuses seem to be less accurate than those estimated for 1950 on the basis of the adjustment for the inclusion of stillbirths. It is this trait of the data (changes in the completeness of parity reporting through time) that invalidates the use of intercensal fertility estimation techniques in Brazil for periods prior to 1970. The biases noticed at the national level are also evident at the regional level, although the data for some regions are slightly better than those for others.

Another characteristic that must be noted is the marked regional variation in fertility that the parity reports reveal. Even as early as 1950, Region 1 (Rio de Janeiro, the site of Brazil's former capital city, and Guanabara) exhibited a fertility level approximately 25 percent below the national average, and as of 1960 both Regions 1 and 2 exhibited fertility levels significantly lower than those for the country as a whole. In contrast, Region 5 has been traditionally a high-fertility area, whose data also appear to be subject to greater biases than those affecting data of the more advanced Regions 1 and 2.

Normally, the lack of information on current fertility (births during the year preceding enumeration) would entirely preclude the use of the Brass procedure for fertility estimation. However, as Carvalho (1974) suggested, it is possible to use the current fertility information gathered by the 1970 census to generate age-specific fertility schedules that can be compared to the average parities reported in 1950 and 1960 via the P/F ratio method. The use of the 1970 data would be justified if the pattern of age-specific fertility had remained constant between 1950 or thereabouts and 1970. Since not enough evidence is available at this stage of the analysis to sustain this hypothesis, we will consider it valid for the moment and evaluate its implications later.

Table 38 presents the 1950 and 1960 fertility schedules derived from the 1970 data and reflecting the total fertility level reported by older women (45-49) at the corresponding census dates (1950 and 1960). As the table indicates, the shape of the age-specific fertility schedules has been adjusted by taking into account the fact that women who reported having had a child during the year preceding the 1970 census reported their age as of the time of enumeration rather than as of the date at which they gave birth. Therefore, on average, they were half-a-year younger at the time of the birth than at the time of enumeration. The adjustment used to derive the schedules presented in Table 38 reduces the effect of this "half-a-year age shift" (see U.N. Manual X, United

TABLE 38 Age-Specific Fertility Rates Adjusted for Half-a-Year Age Shift, 1950-77: Brazil and Regions

Age Group	Fertility Schedules Adjusted for Half-a-Year Age Shift							
	1950[a]	1960[a]	1970	1972	1973	1974	1976	1977
Part 1: Brazil								
15-19	0.077	0.072	0.057	0.053	0.062	0.064	0.060	0.062
20-24	0.261	0.246	0.194	0.176	0.192	0.192	0.169	0.180
25-29	0.302	0.285	0.224	0.207	0.213	0.217	0.184	0.191
30-34	0.251	0.237	0.186	0.172	0.171	0.179	0.154	0.154
35-39	0.186	0.175	0.138	0.122	0.119	0.127	0.106	0.105
40-44	0.087	0.082	0.065	0.056	0.055	0.057	0.048	0.044
45-49	0.023	0.022	0.017	0.011	0.008	0.008	0.009	0.009
TF	5.935	5.597	4.403	3.981	4.101	4.220	3.649	3.724
Adjustment Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Part 2: Region 1								
15-19	0.067	0.059	0.045	0.044	0.052	0.052	0.052	0.044
20-24	0.215	0.191	0.145	0.132	0.148	0.152	0.135	0.137
25-29	0.239	0.212	0.161	0.154	0.149	0.151	0.144	0.150
30-34	0.171	0.151	0.115	0.106	0.108	0.106	0.098	0.111
35-39	0.118	0.104	0.079	0.066	0.078	0.073	0.053	0.060
40-44	0.052	0.046	0.035	0.022	0.024	0.020	0.021	0.025
45-49	0.013	0.012	0.009	0.004	0.004	0.000	0.005	0.003
TF	4.375	3.880	2.944	2.640	2.816	2.763	2.542	2.646
Adjustment Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Part 3: Region 2								
15-19	0.084	0.070	0.048	0.046	0.057	0.056	0.057	0.060
20-24	0.281	0.234	0.161	0.137	0.162	0.159	0.148	0.166
25-29	0.303	0.253	0.174	0.157	0.179	0.174	0.152	0.153
30-34	0.217	0.181	0.124	0.110	0.121	0.124	0.110	0.111
35-39	0.146	0.122	0.084	0.071	0.062	0.071	0.064	0.061
40-44	0.060	0.050	0.034	0.029	0.035	0.035	0.034	0.021
45-49	0.015	0.012	0.008	0.008	0.004	0.008	0.002	0.007
TF	5.524	4.611	3.163	2.781	3.096	3.133	2.835	2.889
Adjustment Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE 38 (continued)

Age Group	Fertility Schedules Adjusted for Half-a-Year Age Shift							
	1950[a]	1960[a]	1970	1972	1973	1974	1976	1977
Part 4: Region 3								
15-19	0.089	0.085	0.064	0.052	0.065	0.063	0.054	0.058
20-24	0.282	0.267	0.202	0.178	0.187	0.196	0.154	0.175
25-29	0.296	0.281	0.212	0.187	0.190	0.206	0.163	0.166
30-34	0.237	0.225	0.170	0.145	0.149	0.159	0.133	0.120
35-39	0.178	0.169	0.128	0.107	0.117	0.097	0.086	0.084
40-44	0.088	0.083	0.063	0.053	0.049	0.057	0.036	0.038
45-49	0.021	0.020	0.015	0.018	0.007	0.007	0.008	0.006
TF	5.955	5.647	4.263	3.694	3.815	3.920	3.173	3.236
Adjustment Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Part 5: Region 4								
15-19	0.064	0.061	0.045	0.042	0.045	0.045	0.045	0.041
20-24	0.267	0.253	0.186	0.164	0.171	0.160	0.160	0.160
25-29	0.327	0.311	0.229	0.194	0.196	0.207	0.185	0.185
30-34	0.287	0.272	0.200	0.183	0.179	0.171	0.148	0.156
35-39	0.223	0.212	0.156	0.143	0.130	0.143	0.121	0.105
40-44	0.109	0.103	0.076	0.077	0.064	0.068	0.054	0.048
45-49	0.028	0.027	0.020	0.013	0.006	0.020	0.012	0.016
TF	6.517	6.191	4.555	4.081	3.955	4.062	3.623	3.547
Adjustment Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Part 6: Region 5								
15-19	0.070	0.070	0.061	0.066	0.073	0.085	0.075	0.077
20-24	0.251	0.252	0.218	0.221	0.239	0.247	0.211	0.221
25-29	0.316	0.318	0.275	0.278	0.281	0.285	0.237	0.256
30-34	0.290	0.291	0.252	0.255	0.246	0.272	0.232	0.231
35-39	0.221	0.222	0.192	0.186	0.175	0.199	0.167	0.177
40-44	0.106	0.107	0.092	0.085	0.084	0.089	0.080	0.076
45-49	0.030	0.030	0.026	0.013	0.015	0.010	0.016	0.012
TF	6.418	6.449	5.584	5.516	5.566	5.928	5.096	5.243
Adjustment Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE 38 (continued)

Age Group	Fertility Schedules Adjusted for Half-a-Year Age Shift							
	1950[a]	1960[a]	1970	1972	1973	1974	1976	1977
Part 7: Region 6								
15-19	--	0.073	0.061	0.039	0.062	0.060	0.050	0.054
20-24	--	0.234	0.195	0.151	0.178	0.183	0.172	0.175
25-29	--	0.266	0.222	0.169	0.190	0.225	0.177	0.200
30-34	--	0.218	0.182	0.119	0.148	0.153	0.131	0.142
35-39	--	0.157	0.131	0.093	0.098	0.128	0.078	0.094
40-44	--	0.073	0.061	0.032	0.033	0.047	0.041	0.030
45-49	--	0.027	0.022	0.019	0.005	0.001	0.005	0.007
TF	--	5.244	4.365	3.099	3.572	3.992	3.271	3.507
Adjustment Factor	--	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Part 8: Region 7								
15-19	0.085	0.087	0.080	--	--	--	--	--
20-24	0.247	0.255	0.234	--	--	--	--	--
25-29	0.282	0.291	0.267	--	--	--	--	--
30-34	0.241	0.248	0.228	--	--	--	--	--
35-39	0.186	0.192	0.176	--	--	--	--	--
40-44	0.090	0.093	0.086	--	--	--	--	--
45-49	0.027	0.027	0.025	--	--	--	--	--
TF	5.781	5.968	5.486	--	--	--	--	--
Adjustment Factor	1.000	1.000	1.000	--	--	--	--	--
Part 9: Region 7, Urban Areas								
15-19	0.064	--	0.057	--	0.071	--	0.065	0.086
20-24	0.211	--	0.187	--	0.200	--	0.181	0.186
25-29	0.253	--	0.224	--	0.214	--	0.187	0.207
30-34	0.207	--	0.184	--	0.173	--	0.125	0.144
35-39	0.156	--	0.139	--	0.121	--	0.099	0.094
40-44	0.072	--	0.064	--	0.050	--	0.044	0.044
45-49	0.019	--	0.017	--	0.012	--	0.008	0.006
TF	4.910	--	4.359	--	4.205	--	3.540	3.829
Adjustment Factor	1.000	--	1.000	--	1.000	--	1.000	1.000

TABLE 38 (continued)

Age Group	Fertility Schedules Adjusted for Half-a-Year Age Shift							
	1950[a]	1960	1970	1972	1973	1974	1976	1977
Part 10: Region 7, Rural Areas								
15-19	0.098	--	0.103	--	--	--	--	--
20-24	0.265	--	0.278	--	--	--	--	--
25-29	0.291	--	0.305	--	--	--	--	--
30-34	0.256	--	0.269	--	--	--	--	--
35-39	0.202	--	0.211	--	--	--	--	--
40-44	0.103	--	0.107	--	--	--	--	--
45-49	0.031	--	0.033	--	--	--	--	--
TF	6.230	--	6.526	--	--	--	--	--
Adjustment Factor	1.000	--	1.000	--	--	--	--	--

--: not available.

[a] Derived from the 1970 census.

Nations, 1983). However, this adjustment does not alter the level of the observed fertility schedules. This fact is indicated in Table 38 by showing that all adjustment factors equal one.

Table 39 presents the results obtained by comparing the average parities of Table 37 (P) with those generated on the basis of the fertility schedules of Table 38 (F). The P/F ratios listed in columns 2 and 3 of Table 39 are all constrained to be one (or approximately so) for age group 45-49 because of the way in which the 1950 and 1960 fertility schedules of Table 38 were constructed. Therefore, only the trend of the P/F ratios for age groups below 45-49 is indicative of inconsistencies between the estimated current fertility schedule and the reported average parities.

For the country as a whole, the P/F ratios for 1950 are fairly close to one and display the trend one would expect if parities tended to be underreported by older women (roughly, they decline as age increases). A similar trend is observed in 1960, but in this instance the P/F ratios deviate somewhat more from one, especially at ages 20-24 and 25-29. Thus, if only these age groups were considered in selecting an adjustment factor for current fertility, the factor for 1960 would be greater than that for 1950, implying that the consistency of the 1960 data

TABLE 39 Estimated P/F Ratios, 1950-77: Brazil and Regions

Age Group	Estimated P/F Ratios							
	1950	1960	1970	1972	1973	1974	1976	1977
Part 1: Brazil								
15-19	1.12	1.03	1.28	1.39	1.07	1.03	1.12	1.10
20-24	1.07	1.14	1.32	1.38	1.19	1.09	1.17	1.14
25-29	0.99	1.07	1.33	1.43	1.26	1.24	1.27	1.20
30-34	0.97	1.02	1.32	1.43	1.34	1.34	1.38	1.31
35-39	0.98	1.02	1.31	1.43	1.39	1.42	1.45	1.41
40-44	0.99	1.01	1.28	1.44	1.41	1.46	1.48	1.45
45-49	1.01	1.01	1.26	1.46	1.43	1.44	1.53	1.50
TF	5.93[a]	5.60[a]	4.40	3.98	4.10	4.22	3.65	3.72
Part 2: Region 1								
15-19	1.06	0.96	1.25	1.45	1.12	1.18	1.08	1.21
20-24	1.01	1.17	1.30	1.42	1.14	1.07	1.08	1.19
25-29	0.89	1.07	1.35	1.40	1.28	1.15	1.21	1.21
30-34	0.88	1.02	1.39	1.47	1.34	1.42	1.33	1.29
35-39	0.91	0.99	1.41	1.52	1.46	1.48	1.39	1.37
40-44	0.95	0.99	1.39	1.50	1.45	1.56	1.54	1.40
45-49	1.00	1.00	1.36	1.54	1.49	1.62	1.51	1.45
TF	4.37[a]	3.88[a]	2.94	2.64	2.82	2.76	2.54	2.65
Part 3: Region 2								
15-19	0.82	0.96	1.20	1.28	1.04	0.95	1.06	1.03
20-24	0.85	1.06	1.25	1.38	1.08	1.01	1.07	1.00
25-29	0.81	0.96	1.32	1.42	1.18	1.14	1.17	1.08
30-34	0.83	0.91	1.34	1.42	1.23	1.28	1.27	1.18
35-39	0.87	0.94	1.35	1.55	1.33	1.49	1.34	1.38
40-44	0.93	0.97	1.35	1.55	1.46	1.55	1.47	1.45
45-49	1.00	1.00	1.39	1.59	1.42	1.52	1.49	1.50
TF	5.52[a]	4.61[a]	3.16	2.78	3.10	3.13	2.84	2.89

TABLE 39 (continued)

Age Group	Estimated P/F Ratios							
	1950	1960	1970	1972	1973	1974	1976	1977
Part 4: Region 3								
15-19	1.01	0.87	1.21	1.39	0.92	0.97	1.10	1.08
20-24	0.95	1.03	1.26	1.38	1.19	1.10	1.27	1.19
25-29	0.92	1.01	1.31	1.47	1.25	1.25	1.38	1.24
30-34	0.93	0.98	1.33	1.50	1.40	1.31	1.48	1.44
35-39	0.96	1.00	1.33	1.55	1.47	1.45	1.60	1.55
40-44	0.98	1.01	1.31	1.59	1.46	1.51	1.64	1.67
45-49	1.01	1.01	1.31	1.56	1.52	1.53	1.78	1.75
TF	5.96[a]	5.65[a]	4.27	3.69	3.82	3.92	3.17	3.24
Part 5: Region 4								
15-19	1.34	1.17	1.31	1.33	1.06	1.05	1.13	1.15
20-24	1.15	1.23	1.37	1.37	1.26	1.31	1.19	1.24
25-29	1.04	1.11	1.41	1.54	1.36	1.44	1.31	1.26
30-34	0.99	1.04	1.42	1.58	1.53	1.58	1.46	1.42
35-39	0.99	1.02	1.40	1.60	1.61	1.65	1.61	1.56
40-44	0.99	1.00	1.36	1.55	1.57	1.76	1.69	1.65
45-49	1.01	1.01	1.34	1.57	1.67	1.73	1.70	1.71
TF	6.52[a]	6.19[a]	4.55	4.08	3.96	4.06	3.62	3.55
Part 6: Region 5								
15-19	1.32	1.13	1.35	1.43	1.18	1.06	1.12	1.14
20-24	1.23	1.19	1.37	1.38	1.25	1.06	1.20	1.17
25-29	1.12	1.14	1.35	1.39	1.26	1.23	1.28	1.23
30-34	1.07	1.10	1.30	1.36	1.33	1.30	1.36	1.30
35-39	1.05	1.06	1.27	1.30	1.31	1.28	1.37	1.33
40-44	1.02	1.03	1.23	1.32	1.35	1.29	1.36	1.33
45-49	1.01	1.01	1.19	1.35	1.32	1.24	1.41	1.37
TF	6.42[a]	6.45[a]	5.58	5.52	5.57	5.93	5.10	5.24

TABLE 39 (continued)

Age Group	Estimated P/F Ratios							
	1950	1960	1970	1972	1973	1974	1976	1977
Part 7: Region 6								
15-19	--	1.75	1.25	2.11	1.06	1.04	1.22	1.19
20-24	--	1.32	1.28	1.55	1.15	1.28	1.17	1.08
25-29	--	1.10	1.25	1.55	1.27	1.31	1.17	1.05
30-34	--	0.92	1.23	1.65	1.34	1.45	1.37	1.15
35-39	--	0.95	1.23	1.63	1.33	1.56	1.43	1.24
40-44	--	0.95	1.26	1.74	1.39	1.65	1.60	1.31
45-49	--	1.01	1.26	1.78	1.50	1.58	1.69	1.43
TF	--	5.24[a]	4.36	3.10	3.57	3.99	3.27	3.51
Part 8: Region 7								
15-19	1.41	1.13	1.32	--	--	--	--	--
20-24	1.27	1.25	1.32	--	--	--	--	--
25-29	1.13	1.16	1.29	--	--	--	--	--
30-34	1.07	1.10	1.26	--	--	--	--	--
35-39	1.04	1.06	1.23	--	--	--	--	--
40-44	1.01	1.03	1.19	--	--	--	--	--
45-49	1.01	1.01	1.14	--	--	--	--	--
TF	5.78[a]	5.97[a]	5.49	--	--	--	--	--

TABLE 39 (continued)

Age Group	Estimated P/F Ratios							
	1950	1960	1970	1972	1973	1974	1976	1977
Part 9: Region 7, Urban Areas								
15-19	1.36	--	1.29	--	0.92	--	1.34	1.00
20-24	1.20	--	1.36	--	1.18	--	1.21	1.14
25-29	1.06	--	1.40	--	1.25	--	1.31	1.20
30-34	1.02	--	1.43	--	1.37	--	1.43	1.31
35-39	1.01	--	1.41	--	1.40	--	1.58	1.41
40-44	1.00	--	1.38	--	1.40	--	1.61	1.43
45-49	1.01	--	1.34	--	1.54	--	1.63	1.52
TF	4.91[a]	--	4.36	--	4.21	--	3.54	3.83
Part 10: Region 7, Rural Areas								
15-19	1.35	--	1.33	--	--	--	--	
20-24	1.25	--	1.29	--	--	--	--	
25-29	1.15	--	1.22	--	--	--	--	
30-34	1.08	--	1.15	--	--	--	--	
35-39	1.06	--	1.13	--	--	--	--	
40-44	1.02	--	1.07	--	--	--	--	
45-49	1.01	--	1.02	--	--	--	--	
TF	6.23[a]	--	6.53	--	--	--	--	

--: not available.

[a] Average parity of women aged 45-49.

with estimated current fertility is less than that of the 1950 data with essentially the same type of fertility schedule.

At the regional level, discrepancies between the observed P's and the estimated F's tend to be even more marked, and it is not always easy to interpret the trends displayed by the P/F ratios with respect to age. For example, for Region 1, the 1950 P/F ratios display almost a U-shaped pattern, indicating that the shape of the 1970 fertility schedule is not consistent with the average parities reported in 1950. However, it is interesting to note that the typical pattern of the P/F ratios when fertility is declining (increasing with age) is not evident in this case.

In contrast, the 1950 P/F ratios for Region 5 (the Northeast) display the typical declining trend that is expected when fertility has been constant and average parity is underreported by older women. The 1960 P/F ratios for this region also display an acceptable trend and both sets suggest that both in 1950 and in 1960 older women grossly underreported their parities (by as much as 16 or 17 percent, perhaps).

These detailed comparisons suggest that, although the discrepancies between P's and F's are relatively small for the country as a whole, they result from far greater ones at the regional level, whose opposing signs tend to cancel each other in the aggregate. As we shall see later, some kind of consistency at the regional level must be achieved before a trustworthy estimate for the country as a whole may be derived.

The 1970 Census and the PNAD Surveys

Tables 37 through 39 also present the basic data and the results obtained by applying the P/F ratio method (United Nations, 1983) to the 1970 census and to most of the surveys carried out during the 1970-80 decade (the 1972, 1973, 1976, and 1977 PNADs and the 1974 ENDEF). Notice that not all regions were covered by all the surveys. The 1972 PNAD did not include Region 7 and all the rest covered only its urban areas. In addition, the ENDEF data for urban Region 7 are not available. Hence, in deriving final estimates for the country as a whole some allowance will have to be made for the missing region which, fortunately, never amounts to more than 4 percent of the total population.

Some of the main characteristics of the basic data (Tables 37 and 38) have already been noted in the previous section. Of special importance is the fact that older women (those over 40) tend to report higher parities in the surveys than in the censuses, with the differences being substantial in certain regions (c.f. Region 5 and Region 7).

The age-specific fertility rates presented in Table 38 are accompanied by the total fertility rates (TF) they imply. These TF values are unadjusted, and their trend at both the country and the regional level is neither smooth nor monotone. Both increases and decreases from one period to the next are evident, although the overall tendency of total fertility is to fall. In general, the TF values produced by the 1973 PNAD are higher than those yielded by the 1972 PNAD, the 1974 ENDEF values are higher than those recorded in 1973, and those of 1977 are higher than those of 1976. However, given the statistical variability inherent in the results of any sample survey, it is likely that the size of the difference between these pairs of adjacent values is not significant.

Both the reported parities of Table 37 and the total fertility rates (TF) of Table 38 reveal the existence of substantial regional differentials with respect to fertility levels. However, these differentials are greater in magnitude when measured in terms of the average parities of older women than when assessed in terms of current, unadjusted, total fertility rates. To the extent that the latter are representative of the true fertility levels in the different regions, this observation suggests that the decline in fertility experienced by the Brazilian population has tended to reduce regional differences.

To assess the degree of consistency existing between recorded average parities and the reported current fertility schedules of Table 38, the P/F ratios implied by these two pieces of evidence have been calculated and are presented in Table 39. In ideal circumstances, when fertility has remained constant and there is no misreporting, the P/F ratios calculated from a given data set should be constant with respect to age. A decreasing trend with age is usually caused by parity understatement at older ages, while an increasing trend usually indicates the existence of a decline in fertility. Of course, the effects of decreasing fertility may interact with parity understatements to produce sets of P/F ratios that fail to decrease consistently as age increases or that do so more slowly than they would if fertility had remained constant. In such cases the P/F ratio sequence may not provide conclusive evidence about the existence of a fertility decline.

In light of these general considerations about the meaning of P/F ratio sequences, it would appear that up to 1970 there is very little evidence substantiating a reduction in fertility for Brazil as a whole: if one disregards the P/F ratio for age group 15-19, the 1970 sequence seems fairly constant up to age group 35-39 and shows a moderate tendency to decline thereafter. Rejection of the first P/F ratio is usual, because the method traditionally employed to estimate parity-equivalents F from observed age-specific fertility rates is rather "rough" and cannot approximate adequately the sharp changes in fertility that take place within the youngest age group of the childbearing span. Recently, however, a more accurate approximation method has been developed (United Nations, 1982), and although the first P/F ratio is still not recommended as a basis for the adjustment of the observed age-specific fertility schedule (if only because it is generally based on very few cases), its reliability in establishing rough trends with respect to age has increased. Thus, accepting the first P/F ratio as valid, the 1970 sequence can be viewed in a different way: as showing a slight increase from 15-19 to 25-29, followed by a slight decline thereafter. The increase at younger ages may be indicative of recent fertility reductions, while the decline at older ones may be caused by the understatement of average parity even among rather young women (those aged 30-34). The likely existence of such bias has already been pointed out in comparing the average pari~~ties repor~~ted by the censuses with those reported by the household surveys, a fact that further substantiates this second interpretation of the 1970 P/F ratio sequence.

In addition, still speaking at the level of the country as a whole, the trend of the 1970 P/F ratios contrasts sharply with that displayed by the ratios corresponding to any of the household surveys conducted between 1972 and 1977. For these surveys, the P/F ratios increase consistently with age, indicating without doubt that a reduction in fertility has taken place. Because it is unlikely that such a process, so evidently apparent according to the 1972 data, may have started only after 1970, the misleading indications attributed at first to the 1970 P/F sequence must be rejected.

While the scope of this report does not allow a detailed analysis and interpretation of the observed P/F ratio sequences at the regional level, some important traits may be highlighted. First, in comparing the trend of the 1970 P/F ratios with the trends exhibited by the ratios estimated for later periods, it is evident that only the former display, if at all, a definitely declining trend at older ages (over 35). The only notable exception to this general observation is provided by Region 5, where even as late as 1974 the P/F ratios fail to display a consistently increasing trend. The frequently divergent behavior of Region 5 (the Northeast) is important because it comprises about 30 percent of Brazil's population, so its impact on the whole is substantial. In contrast, Region 6 (the Federal District) corresponds to at most 1.5 percent of the total population, so that its sometimes erratic estimates have a negligible influence on the national average.

Considering solely the regional estimates yielded by the 1970 census, only Region 2 displays a P/F sequence that increases consistently with age. It can be concluded therefore, that the data for all the other regions is affected by parity understatement. In particular, the fairly sharp decline exhibited by the 1970 P/F ratios of Regions 5 and 7 suggest that their data are subject to greater biases than those of other regions. It is probably because of those regions (5 and 7) that the P/F ratios at the national level fail to display an increasing trend with age.

Considering next, for each region, the P/F ratios for all periods, it can be concluded that Regions 1 and 2 (Rio de Janeiro and Sao Paulo) have experienced a long-term fertility decline that is evident even as early as 1970, if some allowance is made for a certain degree of parity understatement at older ages. Regions 3 and 4 are the "in between" cases where some decline is likely to have occurred prior to 1970, but where the effects of parity understatement have a confounding effect on the 1970 data. Regions 5 and 7 are those where a decline is unlikely to have occurred before 1973 (or even before 1974-75) and where the level of misreporting is probably the highest. Finally, Region 6 is a special case, whose data are subject to greater sampling variability than those for other regions and whose fertility levels are substantially influenced by the heavy immigration it has experienced during recent decades. Hence, although it is certain that its fertility levels have declined since it became Federal District, it is more difficult to establish when the decline started.

The Selection of Adjustment Factors for Age-Specific Fertility During the 1950-77 Period

As mentioned earlier, when there is evidence suggesting the existence of a fertility decline, as is the case for Brazil and its regions, there are no guidelines to direct the choice of an adjustment factor for reported current fertility. Yet, at least two facts suggest that the reported age-specific fertility rates need to be adjusted in order to represent true fertility levels adequately: first, the trends through time of the unadjusted total fertility rates of Table 38 do not seem acceptable. Second, the overall magnitude of the P/F ratios for any one region changes substantially from survey to survey, suggesting that different surveys achieved different levels of completeness of reporting of recent births. In such circumstances, direct comparisons of the unadjusted rates is unwarranted and may be misleading. Therefore, adjustment becomes mandatory. Given the wealth of available data, and the lack of a sound theoretical basis on which to base the choice of adjustment factors, it is probably acceptable to adopt some expedient, even-handed method of adjustment that treats all the data equally. Using the mean of the P/F ratios corresponding to age groups 20-24, 25-29, and 30-34 as adjustment factor produces total fertility rates that, with very few exceptions, decline monotonically over time, so it was adopted as an acceptable adjusting scheme. Table 40 presents the adjusted age-specific fertility rates, the corresponding total fertility rates (TF), and the adjustment factors used.

Two additional comments must be made about the estimates in Table 40. First, given that fertility levels have been changing, they are not likely to refer exactly to the year preceding the survey because they result from the use of an adjustment factor based on the cumulated experience of women who have had most of their children during the 10 years or so preceding the survey. Hence, in later sections they will be assigned a reference period spanning several years in order to convey explicitly the uncertainty surrounding their true reference date. Second, the estimates of Table 40 are by no means definitive. Further analysis is necessary to validate them. They should be treated only as preliminary results.

TABLE 40 Age-Specific Fertility Schedules Adjusted by the Mean of the P/F Ratios Corresponding to Age Groups 20-24, 25-29, and 30-34, 1950-77: Brazil and Regions

	Estimated Fertility Schedules							
Age Group	1950	1960	1970	1972	1973	1974	1976	1977
Part 1: Brazil								
15-19	0.077	0.078	0.075	0.075	0.078	0.078	0.076	0.075
20-24	0.263	0.265	0.256	0.248	0.243	0.235	0.215	0.219
25-29	0.305	0.307	0.297	0.292	0.269	0.265	0.234	0.232
30-34	0.253	0.255	0.247	0.243	0.216	0.219	0.196	0.187
35-39	0.187	0.188	0.183	0.173	0.150	0.155	0.135	0.128
40-44	0.088	0.088	0.086	0.079	0.069	0.070	0.061	0.054
45-49	0.023	0.023	0.023	0.016	0.011	0.010	0.011	0.011
TF	5.987	6.017	5.829	5.622	5.183	5.165	4.641	4.528
Adjustment Factor	1.009	1.075	1.324	1.412	1.264	1.224	1.272	1.216
Part 2: Region 1								
15-19	0.062	0.064	0.061	0.063	0.066	0.063	0.063	0.054
20-24	0.200	0.207	0.196	0.189	0.185	0.184	0.163	0.168
25-29	0.222	0.230	0.217	0.221	0.186	0.183	0.174	0.184
30-34	0.158	0.164	0.155	0.151	0.134	0.128	0.118	0.136
35-39	0.109	0.113	0.107	0.095	0.098	0.088	0.064	0.074
40-44	0.048	0.050	0.047	0.032	0.030	0.024	0.025	0.030
45-49	0.012	0.013	0.012	0.006	0.005	0.000	0.006	0.004
TF	4.058	4.205	3.976	3.780	3.520	3.352	3.072	3.245
Adjustment Factor	0.928	1.084	1.351	1.432	1.250	1.214	1.209	1.226
Part 3: Region 2								
15-19	0.069	0.068	0.063	0.064	0.066	0.064	0.066	0.065
20-24	0.232	0.228	0.209	0.193	0.189	0.182	0.173	0.180
25-29	0.250	0.246	0.226	0.221	0.208	0.199	0.177	0.166
30-34	0.179	0.176	0.162	0.155	0.141	0.142	0.129	0.121
35-39	0.121	0.119	0.109	0.099	0.073	0.082	0.075	0.066
40-44	0.049	0.048	0.045	0.040	0.040	0.040	0.039	0.022
45-49	0.012	0.012	0.109	0.011	0.004	0.009	0.002	0.007
TF	4.565	4.487	4.123	3.915	3.604	3.588	3.307	3.141
Adjustment Factor	0.826	0.973	1.304	1.408	1.164	1.145	1.166	1.087

TABLE 40 (continued)

Age Group	Estimated Fertility Schedules 1950	1960	1970	1972	1973	1974	1976	1977
Part 4: Region 3								
15-19	0.083	0.085	0.083	0.075	0.083	0.076	0.075	0.075
20-24	0.263	0.264	0.262	0.257	0.241	0.239	0.212	0.226
25-29	0.276	0.283	0.276	0.271	0.143	0.251	0.224	0.214
30-34	0.221	0.226	0.221	0.211	0.191	0.195	0.183	0.155
35-39	0.166	0.170	0.166	0.156	0.150	0.118	0.118	0.109
40-44	0.082	0.084	0.082	0.076	0.063	0.070	0.049	0.049
45-49	0.020	0.020	0.020	0.026	0.009	0.008	0.011	0.008
TF	5.553	5.682	5.545	5.355	4.898	4.785	4.368	4.176
Adjustment Factor	0.932	1.006	1.301	1.450	1.284	1.221	1.376	1.290
Part 5: Region 4								
15-19	0.068	0.068	0.063	0.063	0.062	0.064	0.060	0.053
20-24	0.282	0.285	0.261	0.245	0.237	0.230	0.211	0.209
25-29	0.346	0.350	0.320	0.290	0.271	0.298	0.244	0.241
30-34	0.303	0.307	0.280	0.273	0.249	0.247	0.196	0.203
35-39	0.236	0.239	0.218	0.215	0.180	0.206	0.160	0.137
40-44	0.115	0.116	0.106	0.115	0.089	0.097	0.071	0.062
45-49	0.030	0.030	0.027	0.020	0.009	0.028	0.016	0.021
TF	6.898	6.975	6.370	6.103	5.486	5.846	4.790	4.632
Adjustment Factor	1.058	1.127	1.399	1.500	1.387	1.439	1.322	1.306
Part 6: Region 5								
15-19	0.079	0.080	0.081	0.091	0.093	0.101	0.096	0.095
20-24	0.286	0.228	0.292	0.304	0.306	0.295	0.270	0.272
25-29	0.360	0.362	0.368	0.382	0.359	0.339	0.303	0.316
30-34	0.330	0.332	0.338	0.350	0.314	0.324	0.297	0.285
35-39	0.252	0.253	0.257	0.256	0.224	0.237	0.214	0.218
40-44	0.121	0.122	0.124	0.117	0.108	0.106	0.102	0.094
45-49	0.034	0.035	0.035	0.018	0.020	0.011	0.021	0.014
TF	7.309	7.357	7.481	7.586	7.117	7.071	6.513	6.468
Adjustment Factor	1.139	1.141	1.340	1.375	1.279	1.193	1.278	1.234

TABLE 40 (continued)

Age Group	Estimated Fertility Schedules							
	1950	1960	1970	1972	1973	1974	1976	1977
Part 7: Region 6								
15-19	--	0.082	0.077	0.062	0.078	0.081	0.062	0.060
20-24	--	0.260	0.244	0.239	0.223	0.247	0.213	0.191
25-29	--	0.296	0.278	0.268	0.238	0.303	0.219	0.219
30-34	--	0.243	0.228	0.188	0.186	0.207	0.162	0.155
35-39	--	0.175	0.164	0.147	0.122	0.173	0.097	0.103
40-44	--	0.082	0.077	0.050	0.041	0.063	0.050	0.033
45-49	--	0.030	0.028	0.029	0.007	0.002	0.007	0.008
TF	--	5.834	5.466	4.914	4.470	5.377	4.049	3.844
Adjustment Factor	--	1.112	1.252	1.585	1.251	1.347	1.238	1.096
Part 8: Region 7								
15-19	0.098	0.102	0.104	--	--	--	--	--
20-24	0.285	0.298	0.303	--	--	--	--	--
25-29	0.326	0.340	0.346	--	--	--	--	--
30-34	0.278	0.291	0.295	--	--	--	--	--
35-39	0.215	0.225	0.228	--	--	--	--	--
40-44	0.104	0.109	0.111	--	--	--	--	--
45-49	0.031	0.032	0.033	--	--	--	--	--
TF	6.679	6.981	7.090	--	--	--	--	--
Adjustment Factor	1.155	1.170	1.293	--	--	--	--	--
Part 9: Region 7, Urban Areas								
15-19	--	--	--	--	0.090	--	0.087	0.105
20-24	--	--	--	--	0.254	--	0.241	0.227
25-29	--	--	--	--	0.271	--	0.249	0.252
30-34	--	--	--	--	0.219	--	0.166	0.175
35-39	--	--	--	--	0.153	--	0.131	0.114
40-44	--	--	--	--	0.063	--	0.059	0.053
45-49	--	--	--	--	0.015	--	0.011	0.008
TF	--	--	--	--	5.328	--	4.717	4.664
Adjustment Factor	--	--	--	--	1.267	--	1.333	1.218

--: not available.

THE OWN-CHILDREN METHOD

As was stated above, the data required for the application of the own-children method are available from three data sources: the 1960 and 1970 censuses and the 1976 PNAD. In the case of the two censuses, tabulations were made from household samples by matching mothers and children on the basis of stated relationship to the head of the household. For the 1976 PNAD no extraneous matching was required because the questionnaire used during the survey included a question on the identity of the mother of each enumerated child and coded her identification number in the child's record whenever they both lived in the same household.

These procedural differences in the creation of the necessary input tabulations are important because different types of biases are likely to arise depending on them. For example, experience has shown that in societies where extended families are common the matching of mothers and children carried out on the basis of stated relationship to the head of the household tends to assign too many children to relatively old mothers, presumably because some children are matched with their grandmothers rather than with their mothers. Such mismatches introduce a positive bias in the age-specific fertility rates of older women, whose effect in terms of old-age fertility cannot be disregarded, especially given the relatively low rates usually prevalent at those ages.

With this caveat in mind, we proceed to present the results obtained by applying the own-children method to the available data sets. Tables 41 through 43 show the age-specific fertility schedules and the corresponding total fertility rates (TF) obtained for Brazil and its regions from the 1960 and 1970 censuses and from the 1976 PNAD. The fertility schedules displayed in these tables refer to three-year periods. They were obtained by averaging the yearly results that are the usual output of the own-children method. Since the analysis was carried out at the regional as well as at the national level, presentation of the yearly estimates in age-specific forms would be more overwhelming than useful. However, for the purposes of evaluation, the total fertility rates associated with the yearly age-specific fertility estimates are displayed graphically in Figures 17 through 23.

Before evaluating the results obtained, it must be recalled that the own-children method depends essentially on the principles of reverse projection, and thus it suffers from the same deficiencies usually associated with that method. In particular, errors in the recorded age distribution, either of children or of females, cause serious biases in the estimates obtained. In addition, application of the method requires detailed estimates of mortality for the 15-year period preceding the time of interview. Obviously, any error in these estimates will affect the fertility estimates too. However, in practice, biases due to errors in the mortality estimates used are usually minor compared to those due to age-misreporting and differential undercounts by age.

In the case at hand, the fertility estimates that may be derived from the available data sources cover the 1946-76 period, hence mortality estimates for the same period are required. The yearly series of life tables whose derivation was described in the previous chapter was used to apply the own-children method. Therefore, due allowance was made for changes of mortality through time and for the existence of regional differentials in mortality.

Because the own-children method is designed to estimate fertility in closed populations, its use to obtain fertility estimates at the regional level poses some problems, especially with respect to the interpretation of the results obtained. To the extent that the fertility of the population that is lost by emigration or gained through immigration differs from that of the average native population, the estimates yielded by the own-children method will be biased. In the case of Brazil, at the national level such biases are likely to be fairly small, since international migration has not been an important determinant of population growth during the period considered. The same cannot be said for the different regions, whose gain and loss of population through internal migration has been significant. The question arises therefore about how well the reverse-projected number of children now in a given region represent the number of births occurring to the population in that region at some previous point in time. Without detailed estimates of fertility differentials by migratory status and information on the time of arrival of migrants to the region of enumeration, a definitive answer to this question cannot be given. However, one thing remains certain: as long as international migration levels are low, the weighted average of the regional estimates of fertility derived by the own-children method (weighted in terms of the regional distribution of the

TABLE 41 Own-Children Estimates of Fertility by Three-Year Periods Derived from the 1960 Census: Brazil and Regions

AGE	1958-60	1955-57	1952-54	1949-51	1946-48
15-19	0.0750	0.0980	0.1032	0.0999	0.1067
20-24	0.2140	0.2582	0.2588	0.2520	0.2548
25-29	0.2238	0.2773	0.2873	0.2653	0.2793
30-34	0.1915	0.2351	0.2389	0.2281	0.2450
35-39	0.1332	0.1629	0.1725	0.1674	0.1731
40-44	0.0672	0.0864	0.0902	0.0872	0.0992
45-49	0.0277	0.0363	0.0397	0.0428	0.0431
TFR	4.6610	5.7709	5.9531	5.7132	6.0061

BRAZIL

AGE	1958-60	1955-57	1952-54	1949-51	1946-48
15-19	0.0636	0.0717	0.0720	0.0667	0.0734
20-24	0.1789	0.2079	0.1961	0.1881	0.1822
25-29	0.1687	0.2011	0.2001	0.1926	0.2003
30-34	0.1269	0.1495	0.1615	0.1513	0.1526
35-39	0.0824	0.0951	0.1017	0.0966	0.0969
40-44	0.0350	0.0546	0.0568	0.0448	0.0590
45-49	0.0206	0.0223	0.0245	0.0269	0.0245
TFR	3.3806	4.0106	4.0637	3.8352	3.9446

REGION 1

AGE	1958-60	1955-57	1952-54	1949-51	1946-48
15-19	0.0725	0.0881	0.0868	0.0786	0.0788
20-24	0.2093	0.2381	0.2287	0.2179	0.2333
25-29	0.1929	0.2228	0.2319	0.2214	0.2476
30-34	0.1450	0.1764	0.1806	0.1855	0.2019
35-39	0.1004	0.1145	0.1245	0.1277	0.1416
40-44	0.0492	0.0583	0.0629	0.0643	0.0748
45-49	0.0206	0.0251	0.0284	0.0250	0.0284
TFR	3.9442	4.6161	4.7191	4.6015	5.0325

REGION 2

AGE	1958-60	1955-57	1952-54	1949-51	1946-48
15-19	0.0760	0.0946	0.1002	0.0961	0.0925
20-24	0.2257	0.2670	0.2709	0.2665	0.2592
25-29	0.2363	0.2800	0.2843	0.2654	0.2737
30-34	0.1970	0.2343	0.2446	0.2341	0.2518
35-39	0.1361	0.1731	0.1815	0.1751	0.1821
40-44	0.0733	0.0886	0.0936	0.0875	0.1017
45-49	0.0253	0.0281	0.0340	0.0357	0.0374
TFR	4.8488	5.8284	6.0452	5.8024	5.9924

REGION 3

AGE	1958-60	1955-57	1952-54	1949-51	1946-48
15-19	0.0757	0.1083	0.1118	0.1104	0.1263
20-24	0.2201	0.2752	0.2827	0.2719	0.2750
25-29	0.2414	0.3114	0.3205	0.2903	0.3081
30-34	0.2161	0.2741	0.2630	0.2437	0.2693
35-39	0.1573	0.1876	0.1923	0.1758	0.1921
40-44	0.0799	0.0987	0.0990	0.1001	0.1158
45-49	0.0254	0.0374	0.0422	0.0476	0.0468
TFR	5.0788	6.4635	6.5569	6.1986	6.6674

REGION 4

AGE	1958-60	1955-57	1952-54	1949-51	1946-48
15-19	0.0738	0.0996	0.1098	0.1137	0.1288
20-24	0.2109	0.2620	0.2729	0.2743	0.2754
25-29	0.2407	0.3183	0.3333	0.3010	0.3155
30-34	0.2227	0.2776	0.2805	0.2666	0.2850
35-39	0.1526	0.1946	0.2126	0.2039	0.2010
40-44	0.0782	0.1066	0.1096	0.1083	0.1189
45-49	0.0337	0.0488	0.0513	0.0561	0.0583
TFR	5.0628	6.5374	6.8503	6.6190	6.9149

REGION 5

AGE	1958-60	1955-57	1952-54	1949-51	1946-48
15-19	0.0948	0.1298	0.1473	0.1363	0.1437
20-24	0.2430	0.3040	0.2979	0.2820	0.2831
25-29	0.2529	0.3138	0.3265	0.2956	0.2960
30-34	0.2302	0.2713	0.2794	0.2651	0.2856
35-39	0.1576	0.1976	0.1980	0.2029	0.2089
40-44	0.0849	0.1001	0.1066	0.1154	0.1237
45-49	0.0421	0.0561	0.0653	0.0781	0.0619
TFR	5.5278	6.8629	7.1060	6.8769	7.0147

REGION 7

TABLE 42 Own-Children Estimates of Fertility by Three-Year Periods Derived from the 1970 Census: Brazil and Regions

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.0696	0.0912	0.1045	0.1086	0.1101
20-24	0.2080	0.2543	0.2689	0.2682	0.2759
25-29	0.2249	0.2716	0.2870	0.2846	0.2841
30-34	0.1852	0.2267	0.2327	0.2319	0.2397
35-39	0.1317	0.1539	0.1680	0.1661	0.1619
40-44	0.0615	0.0754	0.0772	0.0750	0.0831
45-49	0.0150	0.0177	0.0178	0.0205	0.0220
TFR	4.4790	5.4540	5.7810	5.7743	5.8837

BRAZIL

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.0546	0.0675	0.0713	0.0794	0.0780
20-24	0.1653	0.1939	0.2120	0.2164	0.2260
25-29	0.1662	0.1959	0.2229	0.2301	0.2168
30-34	0.1221	0.1513	0.1598	0.1561	0.1566
35-39	0.0797	0.0965	0.0996	0.1017	0.1136
40-44	0.0325	0.0415	0.0437	0.0459	0.0443
45-49	0.0095	0.0128	0.0110	0.0098	0.0128
TFR	3.1493	3.7964	4.1021	4.1962	4.2407

REGION 1

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.0552	0.0716	0.0816	0.0881	0.0842
20-24	0.1760	0.2133	0.2253	0.2314	0.2372
25-29	0.1737	0.2117	0.2271	0.2275	0.2334
30-34	0.1283	0.1553	0.1630	0.1734	0.1780
35-39	0.0799	0.0956	0.1076	0.1111	0.1124
40-44	0.0329	0.0409	0.0481	0.0426	0.0586
45-49	0.0066	0.0090	0.0094	0.0103	0.0131
TFR	3.2626	3.9870	4.3100	4.4218	4.5850

REGION 2

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.0787	0.0968	0.1053	0.1126	0.1133
20-24	0.2225	0.2598	0.2801	0.2827	0.2860
25-29	0.2266	0.2657	0.2830	0.2930	0.2870
30-34	0.1772	0.2191	0.2328	0.2375	0.2376
35-39	0.1345	0.1589	0.1650	0.1763	0.1766
40-44	0.0637	0.0741	0.0848	0.0864	0.0906
45-49	0.0140	0.0173	0.0176	0.0209	0.0199
TFR	4.5864	5.4588	5.8431	6.0470	6.0547

REGION 3

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.0578	0.0821	0.1012	0.1124	0.1239
20-24	0.2016	0.2502	0.2777	0.2897	0.2987
25-29	0.2383	0.2879	0.3021	0.3052	0.3142
30-34	0.2028	0.2492	0.2566	0.2591	0.2782
35-39	0.1472	0.1739	0.2000	0.1970	0.1817
40-44	0.0714	0.0919	0.0844	0.0852	0.0939
45-49	0.0165	0.0161	0.0179	0.0188	0.0220
TFR	4.6783	5.7570	6.1998	6.3363	6.5627

REGION 4

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.0746	0.1054	0.1248	0.1216	0.1202
20-24	0.2267	0.2923	0.3008	0.2856	0.2906
25-29	0.2659	0.3340	0.3475	0.3248	0.3270
30-34	0.2430	0.3000	0.2989	0.2887	0.3005
35-39	0.1749	0.2074	0.2269	0.2101	0.1922
40-44	0.0884	0.1059	0.1057	0.0997	0.1035
45-49	0.0214	0.0253	0.0271	0.0304	0.0301
TFR	5.4749	6.8517	7.1583	6.8045	6.8207

REGION 5

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.0705	0.0709	0.0964	0.0832	0.0748
20-24	0.2242	0.2557	0.2666	0.2166	0.2516
25-29	0.2290	0.2782	0.2976	0.2351	0.2691
30-34	0.1639	0.2201	0.2290	0.1829	0.1935
35-39	0.1162	0.1386	0.1856	0.1555	0.1721
40-44	0.0464	0.0845	0.0682	0.1157	0.0660
45-49	0.0069	0.0220	0.0073	0.0176	0.0
TFR	4.2861	5.3497	5.7531	5.0[illegible]	5.1357

REGION 6

AGE	1968-70	1965-67	1962-64	1959-61	1956-58
15-19	0.1014	0.1232	0.1386	0.1417	0.1600
20-24	0.2499	0.2978	0.3109	0.3142	0.3352
25-29	0.2562	0.3158	0.3308	0.3337	0.3254
30-34	0.2266	0.2745	0.2802	0.2854	0.2754
35-39	0.1724	0.1941	0.2105	0.1925	0.2168
40-44	0.0819	0.0929	0.0862	0.0935	0.1220
45-49	0.0237	0.0288	0.0271	0.0394	0.0446
TFR	5.5600	6.6357	6.9214	7.0022	7.3970

REGION 7

TABLE 43 Own-Children Estimates of Fertility by Three-Year Periods Derived from the 1976 PNAD: Brazil and Regions

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0624	0.0658	0.0745	0.0848	0.0897
20-24	0.1726	0.1970	0.2143	0.2365	0.2466
25-29	0.1879	0.2203	0.2437	0.2480	0.2594
30-34	0.1531	0.1791	0.1885	0.2020	0.2188
35-39	0.1017	0.1202	0.1398	0.1454	0.1568
40-44	0.0498	0.0586	0.0695	0.0729	0.0715
45-49	0.0085	0.0124	0.0177	0.0174	0.0138
TFR	3.6800	4.2666	4.7399	5.0351	5.2836

WHOLE COUNTRY

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0547	0.0546	0.0575	0.0694	0.0760
20-24	0.1466	0.1472	0.1696	0.1931	0.2018
25-29	0.1581	0.1729	0.1872	0.1865	0.2051
30-34	0.1071	0.1190	0.1194	0.1538	0.1457
35-39	0.0531	0.0667	0.0844	0.0881	0.0981
40-44	0.0272	0.0285	0.0314	0.0428	0.0354
45-49	0.0054	0.0085	0.0145	0.0131	0.0097
TFR	2.7610	2.9876	3.3200	3.7345	3.8591

REGION 1

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0587	0.0536	0.0571	0.0686	0.0774
20-24	0.1583	0.1748	0.1758	0.1904	0.2145
25-29	0.1641	0.1757	0.1845	0.1953	0.2168
30-34	0.1143	0.1252	0.1359	0.1501	0.1622
35-39	0.0669	0.0788	0.0917	0.0956	0.1130
40-44	0.0378	0.0379	0.0381	0.0407	0.0442
45-49	0.0025	0.0059	0.0106	0.0093	0.0052
TFR	3.0136	3.2601	3.4692	3.7500	4.1662

REGION 2

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0638	0.0723	0.0816	0.0892	0.0973
20-24	0.1722	0.2098	0.2271	0.2595	0.2752
25-29	0.1826	0.2089	0.2396	0.2610	0.2793
30-34	0.1377	0.1707	0.1955	0.2052	0.2316
35-39	0.0887	0.1140	0.1343	0.1538	0.1816
40-44	0.0403	0.0589	0.0743	0.0803	0.0704
45-49	0.0075	0.0106	0.0131	0.0179	0.0138
TFR	3.4640	4.2266	4.8274	5.3343	5.7458

REGION 3

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0521	0.0581	0.0688	0.0841	0.0892
20-24	0.1764	0.1954	0.2217	0.2564	0.2689
25-29	0.1946	0.2361	0.2630	0.2907	0.2948
30-34	0.1804	0.1988	0.2088	0.2452	0.2642
35-39	0.1165	0.1478	0.1701	0.1848	0.1745
40-44	0.0603	0.0746	0.0758	0.0843	0.0898
45-49	0.0100	0.0179	0.0183	0.0168	0.0189
TFR	3.9510	4.6431	5.1325	5.8111	6.0017

REGION 4

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0754	0.0780	0.0924	0.1001	0.0977
20-24	0.2042	0.2262	0.2499	0.2624	0.2569
25-29	0.2369	0.2768	0.3069	0.2885	0.2881
30-34	0.2160	0.2442	0.2474	0.2474	0.2739
35-39	0.1615	0.1726	0.2013	0.1917	0.1994
40-44	0.0790	0.0838	0.1086	0.1023	0.1031
45-49	0.0152	0.0186	0.0286	0.0272	0.0208
TFR	4.9410	5.5007	6.1762	6.0985	6.2003

REGION 5

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0548	0.0592	0.0609	0.0850	0.0919
20-24	0.1752	0.1815	0.2061	0.2299	0.2539
25-29	0.1741	0.2059	0.2286	0.2549	0.2813
30-34	0.1350	0.1557	0.1982	0.2227	0.2277
35-39	0.0903	0.1178	0.1332	0.1230	0.1448
40-44	0.0433	0.0501	0.0621	0.0716	0.0726
45-49	0.0087	0.0110	0.0159	0.0121	0.0156
TFR	3.4072	3.9064	4.5248	4.9965	5.4388

REGION 6

AGE	1974-76	1971-73	1968-70	1965-67	1962-64
15-19	0.0781	0.0789	0.0899	0.1000	0.1113
20-24	0.2031	0.2174	0.2455	0.2799	0.2704
25-29	0.2040	0.2419	0.2722	0.2512	0.2701
30-34	0.1531	0.1926	0.2067	0.2054	0.2182
35-39	0.1080	0.1224	0.1354	0.1561	0.1465
40-44	0.0421	0.0560	0.0667	0.0911	0.0869
45-49	0.0134	0.0093	0.0193	0.0173	0.0162
TFR	4.0095	4.5928	5.1785	5.3048	5.5981

REGION 7 (Urban)

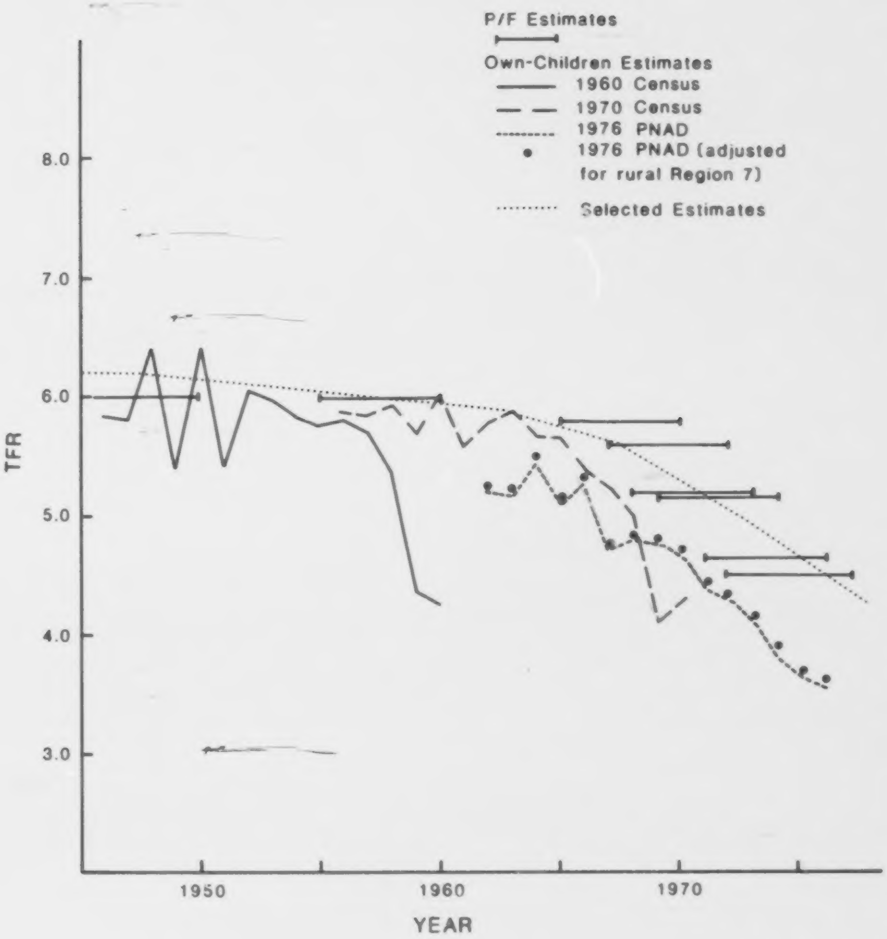


FIGURE 17 Comparison of Total Fertility Estimates, 1946-77: Brazil

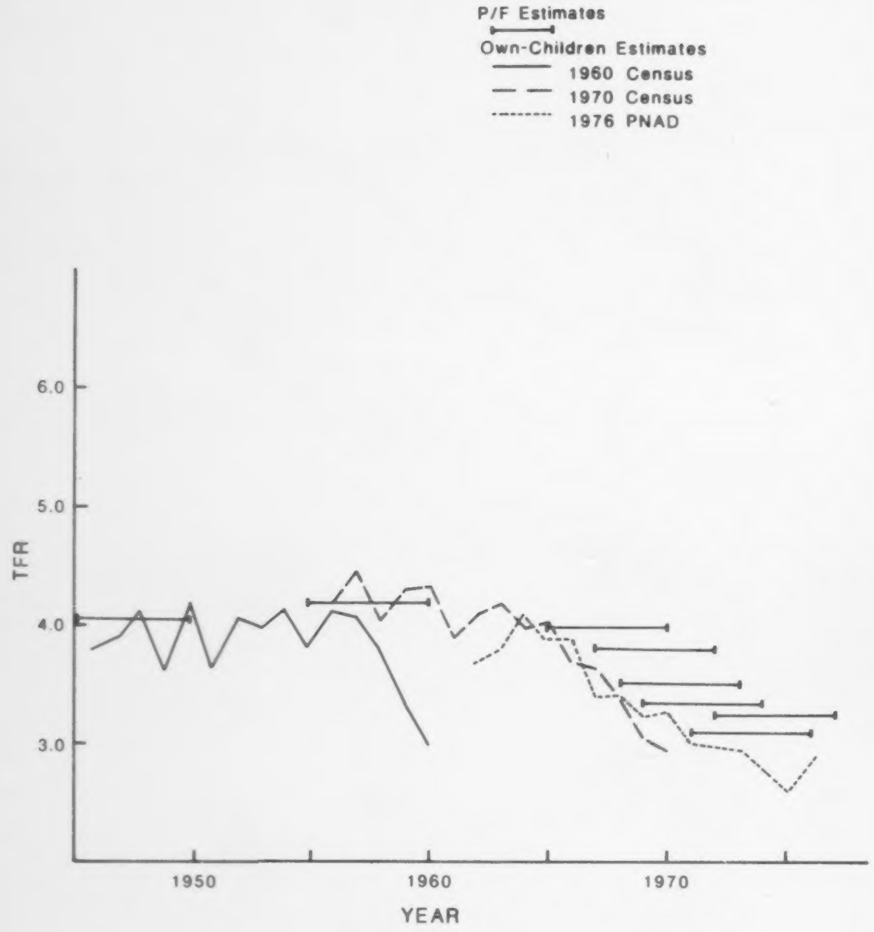


FIGURE 18 Comparison of Total Fertility Estimates, 1946-77, Region 1: Brazil

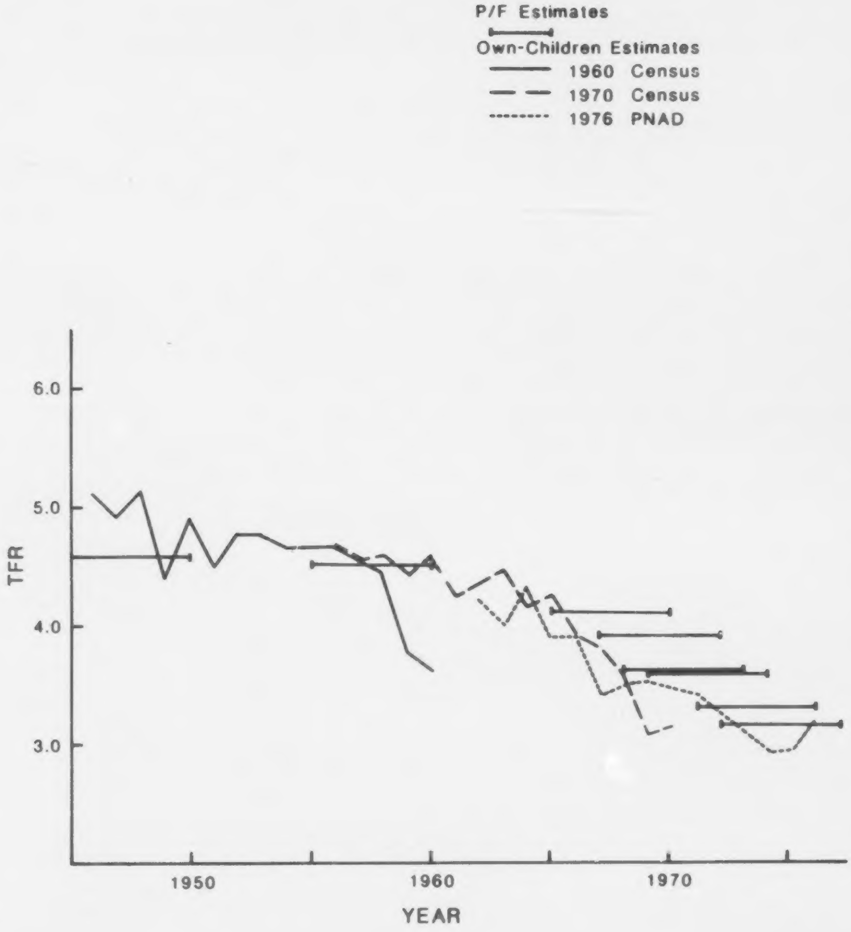


FIGURE 19 Comparison of Total Fertility Estimates, 1946-77, Region 2: Brazil

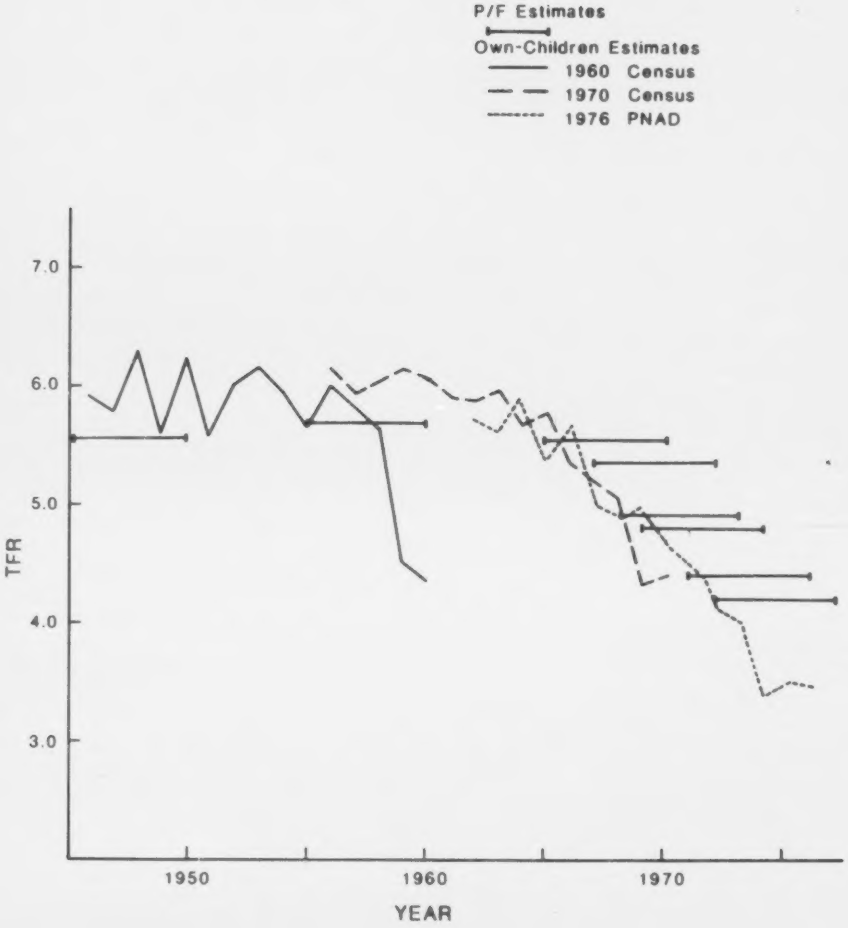


FIGURE 20 Comparison of Total Fertility Estimates, 1946-77, Region 3: Brazil

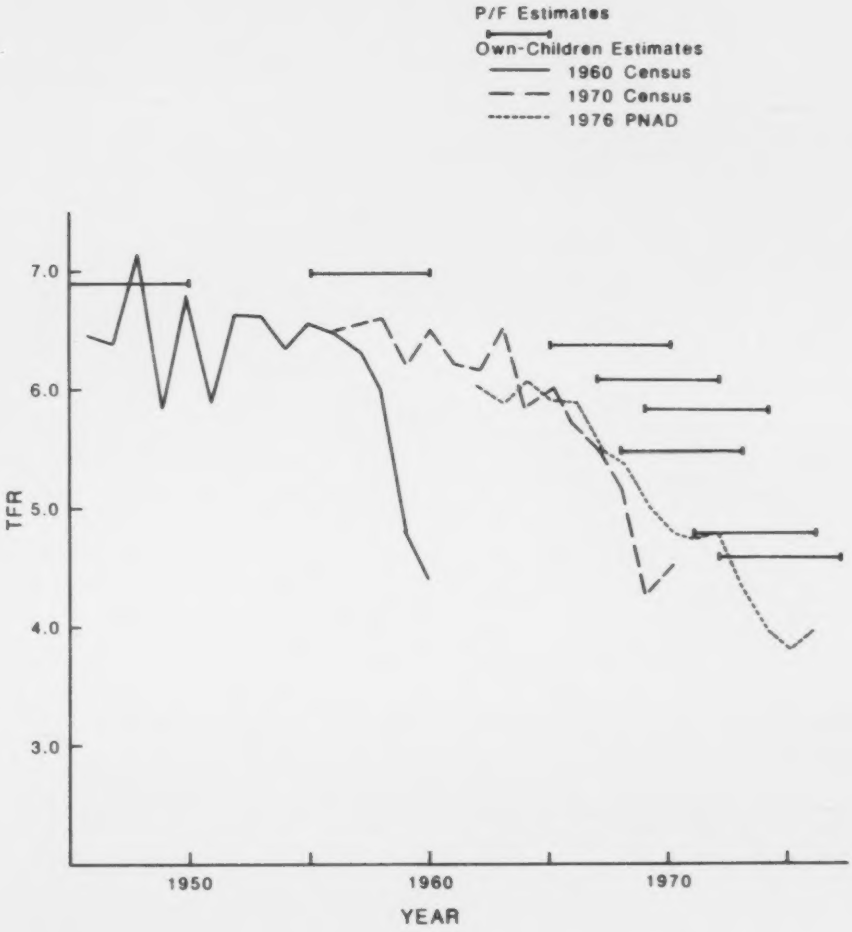


FIGURE 21 Comparison of Total Fertility Estimates, 1946-77, Region 4: Brazil

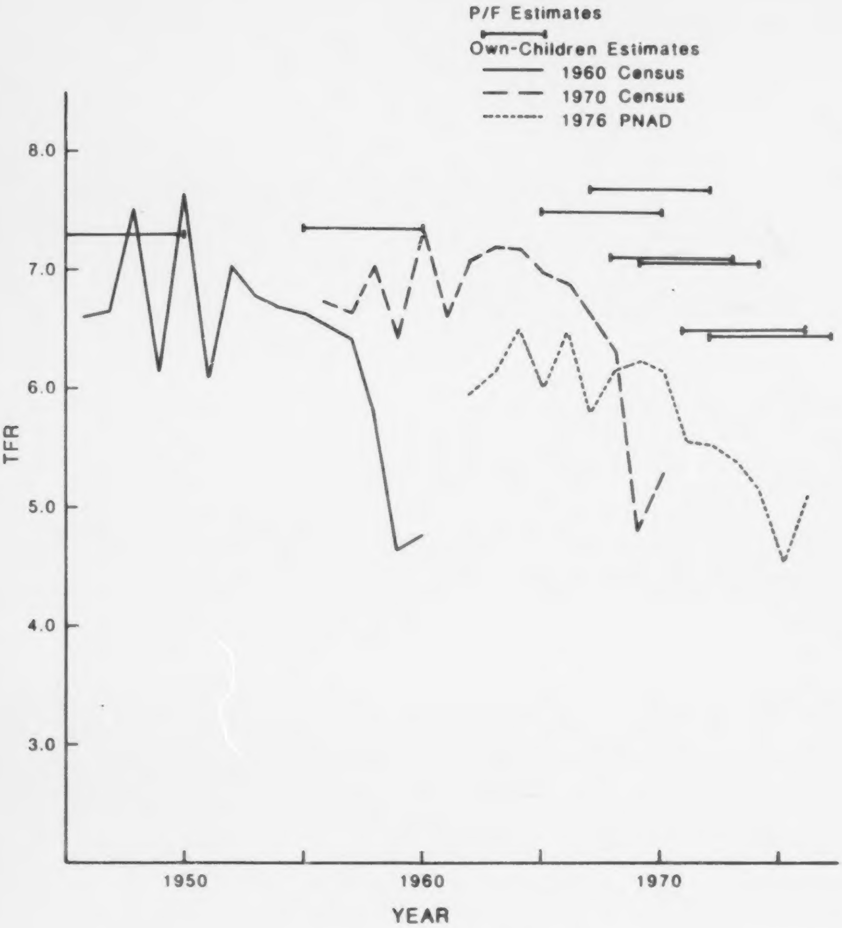


FIGURE 22 Comparison of Total Fertility Estimates, 1946-77, Region 5: Brazil

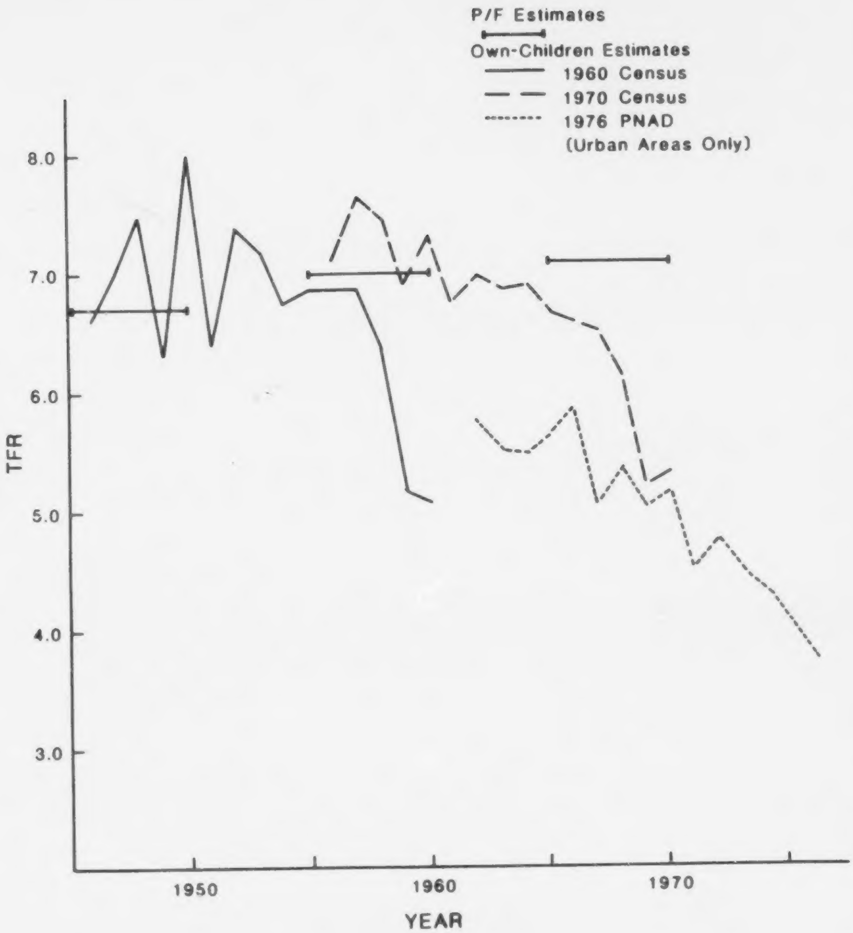


FIGURE 23 Comparison of Total Fertility Estimates, 1946-77, Region 7: Brazil

population at the time of enumeration) is representative of fertility at the national level both at the time of enumeration and for previous periods. Therefore, in the discussion that follows, although regional estimates will be considered separately, emphasis will be given to their implications in terms of the national average.

Own-Children Estimates for Brazil as a Whole

Figure 17 displays the yearly estimates of total fertility derived from the own-children data for the country as a whole. The three distinct curves correspond to the estimates derived from each of the available data sources. Especially striking is the high degree of age heaping exhibited by the 1960 data, which is reflected by the peaks and troughs displayed by the total fertility estimates for the 1946-52 period (associated with ages 9-14). Although similar distortions are observed in the other two sets of estimates, their magnitude is substantially smaller, suggesting that better age reporting was achieved in 1970 and 1976 than in 1960.

Another feature shared by all three sets of estimates is the sharply declining trend displayed by the total fertility estimates derived from children aged 0-4 at the time of enumeration. Such a trend is characteristic of estimates derived by using the own-children method and it is caused by the joint action of differential completeness of enumeration by age and age misreporting. Since the periods for which estimates from different sources overlap include, in particular, the declining sections of the 1960 and 1970 sets, it is evident that their most recent estimates (those derived from children aged 0 and 1) are too low. In the case of the 1960 data, one can argue that even the estimates associated with ages 2, 3, and maybe 4 (1956-58) are biased downward. For 1970, however, the total fertility estimates for the 1962-68 period (corresponding to ages 2 to 8) fall consistently above the estimates for the same period derived from the 1976 PNAD (corresponding to ages 8 to 14). Since usual patterns of age misreporting and differential undercount would lead us to expect the inverse relationship (i.e., that the estimates derived from the 1976 PNAD were greater than those derived from the 1970 census), the observed outcome casts doubts on the accuracy of the estimates derived from the PNAD survey.

One can argue, however, that the PNAD-based estimates cannot be expected to match those yielded by the census because the former do not include the rural areas of Region 7, whose fertility is higher than average. In order to determine roughly the size of the bias due to this omission, a modified set of PNAD own-children estimates was derived by weighting the data for Region 5 by the combined sizes of Region 5 and rural Region 7. Since the fertility levels of these two regions are similar, such a procedure would enhance the representativity of the PNAD estimates at the national level. The modified own-children estimates are displayed in Figure 17. Although consistently greater than the original ones, the difference between the two is hardly significant, and it is certainly not able to account for the large discrepancies observed during the 1962-68 period.

In spite of their flaws, the sets of total fertility estimates displayed in Figure 17 confirm that fertility remained more or less constant until 1965, so that any reduction in fertility levels must have taken place since then. In addition, even though the 1976 data seem weaker than the rest in terms of overall level, it is clear that they imply a declining trend which is consistent with that displayed by fertility estimates derived from information on births last year (see Table 40).

Regional Own-Children Estimates

Examination of the estimates at the regional level sheds some light on the likely causes of the discrepancies observed at the national level. There are two main points to be noted.

First, as Figures 18 through 21 show, the estimates derived from the 1970 census coincide fairly well with those obtained from the 1976 PNAD data for Regions 1 to 4. Furthermore, in all of these regions the trend followed by the total fertility estimates after 1965 is clearly declining, while prior to 1965 only the estimates of Region 2 show some tendency to decrease.

Second, for Regions 5 and 7, large discrepancies are observed between the estimates derived from the 1970 census data and those derived from the 1976 PNAD. The discrepancies for Region 7 would have been expected, since the 1976 PNAD estimates refer only to its urban areas, while all the rest refer to both urban and rural populations combined. But the differences evident in the estimates for Region 5 are unexpected and have no other justification than the existence of serious reporting errors. Evidently, given the large weight that Region 5 has on the national average (it amounts to about 30 percent of the total), biases affecting its data have significant effects at the national level. Thus, it is not surprising to find that the PNAD estimates for Brazil as a whole are lower than expected.

It must also be noted that, although the overall level of the PNAD estimates for Region 5 is wrong, their trend through time need not necessarily be so. If one accepts it as roughly valid, one can assert that fertility did not decrease in Region 5 prior to 1972 or 1973. Declines may have occurred thereafter, although the own-children estimates provide no foundation on which to validate such a trend.

To conclude, note that the yearly estimates for Region 6 (the Federal District) have been omitted. The reason for this omission is that because it constitutes such a small percentage of the total population (at most 2 percent), its share in the equal-probability samples used to derive the own-children tabulations from the 1960 and 1970 censuses is too small to provide useful estimates. The partial cumulation carried out in deriving the estimates for three-year periods presented in Tables 42 and 43 contributes to the reduction of this problem, but again, the low weight that Region 6 has on the national average does not warrant the detailed analysis of its data.

A REVISED SET OF FERTILITY ESTIMATES FOR BRAZIL AS A WHOLE

Two sets of fertility estimates covering approximately the 1945-77 period have been presented in previous sections. Although each set conveys valuable information about the evolution of fertility in Brazil and its regions since 1945, none is entirely free from error. Therefore, a careful evaluation of the strengths and weaknesses of each is necessary before a definitive set of estimates can be selected.

The most important deficiencies of the available sets have already been noted: the estimates of Table 40, based on the P/F ratio method and henceforward called "P/F estimates," have been derived by choosing an adjustment factor in a rather arbitrary fashion, and although they probably do reflect generally the levels of fertility prevalent during some period, the decline of fertility suggested by other evidence makes the determination of their true reference dates elusive. On the other hand, the estimates derived via the own-children method (called "own-children estimates" from now on) are affected both by age misreporting and by differential completeness of coverage by age, so that both the levels and the trends they imply (if interpreted strictly) are likely to be wrong. They constitute, however, the best basis available for the determination of trends, provided that estimates derived from certain age groups (very young children, for example) are disregarded.

The availability of regional estimates has brought to light other deficiencies: it appears that the own-children estimates for Region 5 derived from the 1976 PNAD are severely biased downward, causing the same type of bias to appear at the national level. One can only speculate about the causes of such bias, but its existence implies that one cannot use the country-wide 1976 own-children estimates as guidelines in selecting recent fertility levels.

For earlier periods (1945-60) the problems encountered are of a different nature: the lack of data prompted the fabrication of fertility schedules based on more recent information, a scheme that resulted in a set of P/F estimates whose validity is often doubtful. Estimates for the same period are available from the 1960 own-children estimates and, after 1955, from the 1970 set. Unfortunately, for 1945-55 the 1960 estimates are substantially affected by age heaping, so they are of little help in reducing the uncertainties surrounding the estimates for this period. For 1955-60 the evidence seems less ambiguous and more likely to yield acceptable estimates.

To obtain a better idea of how the two sets of estimates being considered compare, refer to Figures 17 through 23. Note that all the P/F estimates are represented by horizontal lines spanning periods of five years before the date of their respective source. As Figures 18 through 20 reveal, for Regions 1, 2, and 3 the P/F estimates are fairly consistent with the own-children ones, provided the reference date of the former is taken to be five years before interview. For Region 4 (see Figure 21), the discrepancies between the P/F and own-children estimates are larger, the P/F frequently being greater than the own-children. For Region 5 (Figure 22), the discrepancies between the two sets are even more marked, and although the P/F estimates do indicate that a decline has taken place, their levels are substantially higher than those implied by the own-children estimates. Finally, for Region 7 (Figure 23) the few comparisons possible show that, for 1955-70 the P/F estimates are not inconsistent with those derived from own-children data.

Although the P/F and the own-children estimates are in good agreement for some of the country's regions, the discrepancies noted in Regions 4 and 5 are all too patently reflected on the national average, since for Brazil as a whole (see Figure 17) it is clear that the P/F estimates are usually greater than those obtained from own-children data.

In conclusion, it appears that none of the sets of estimates derived so far is in and of itself adequate for the country as a whole. However, the relatively good agreement observed between the two sets for certain regions, and our knowledge about the biases that are most likely to affect the others make it possible to derive an alternative set of country-wide estimates on the basis of the most reliable ones at the regional level. The derivation of this set is described below.

A Revised Set of Total Fertility Estimates for Brazil as a Whole

Table 44 presents the data used in deriving total fertility estimates for the whole country on the basis of the most reliable ones obtained at the regional level. The country-wide estimate is calculated as the weighted average of the regional estimates, using as weights the proportions of women aged 15-49 in each region. The weights are also presented in Table 44. Those for periods before 1971 were computed from the 1950, 1960, and 1970 censuses. The weights for the period labeled 1971-76 were obtained from the 1976 PNAD tabulations (which show the estimated population in each region classified by age and sex) and they exclude the rural population of Region 7. Therefore, strictly speaking, the country-wide total fertility estimate for 1971-76 shown in Table 44 needs to be adjusted to take into account the missing region. Assuming that its population amounted to 4 percent of the total and that it had a total fertility rate of 7.5 during the approximate period considered, the resulting country estimate is 4.60 children per woman.

TABLE 44 Derivation of Revised Total Fertility Estimated for the Whole Country, 1945-76: Brazil

	About 1945-50			About 1955-60		
Region	Weight	TF	Source	Weight	TF	Source
1	0.099	4.40	1950 P/F(2)	0.102	4.20	1960 P/F
2	0.182	4.70	1950 P/F(2,3)	0.191	4.50	1960 P/F
3	0.147	6.00	1960 OC	0.163	6.00	1970 OC
4	0.164	6.50	1960 OC	0.152	6.50	1970 OC
5	0.342	7.30	1970 OC	0.317	7.30	1970 OC
6	0.000	--	--	0.002	5.10	1970 OC
7	0.066	7.0[illegible]	1960 P/F	0.073	7.00	1960 PF
Total	1.000	6.20		1.000	6.09	

	About 1965-70			About 1971-76		
Region	Weight	TF	Source	Weight[a]	TF	Source
1	0.106	4.00	1970 P/F	0.112	3.25	1977 P/F
2	0.202	4.10	1970 P/F	0.219	3.31	1976 P/F
3	0.173	5.60	1970 P/F	0.189	4.37	1976 P/F
4	0.138	6.40	1970 P/F	0.136	4.79	1976 P/F
5	0.294	7.30	1970 OC	0.288	6.51	1976 P/F
6	0.006	5.00	1970 P/F	0.009	4.05	1976 P/F
7	0.081	7.00	1970 P/F	0.046	4.72	1976 P/F
Total	1.000	5.85		0.999	4.48	

Note: When an estimate corresponding to the rural population of Region 7 is added to the calculations, the TF estimate for 1971-76 increases to 4.60.

[a] Excluding rural areas of Region 7.

Table 44 also indicates the source of the regional estimates selected. The P/F estimates are identified by the data of their source (1950, 1960, 1970, etc.) and, occasionally, by the age groups whose P/F ratios were used to adjust the observed fertility schedule (2 stands for 20-24, 3 for 25-29). Whenever the age-group indicators are missing, the P/F estimates are those presented in Table 40.

The own-children estimates are also accompanied by the date of their data source. However, no attempt was made to indicate exactly from which period they were extracted. In some cases, the own-children estimates selected correspond to a given year (1949-50 for example), while in others they are rough averages of the yearly estimates of a whole period (1946-54 for example).

Another item of Table 44 that is less precise than one might wish are the "period indicators" (about 1945-50, about 1955-60). They are used to show explicitly that the estimates presented do not have a very specific reference date, even though, especially for periods after 1965, they were obtained from sources located at the end of the period indicated (the 1970 census and the 1976 PNAD).

It is noteworthy that most of the estimates selected for periods prior to 1960 were derived from the own-children set, while the majority of those selected for later periods are P/F estimates. This strategy had to be followed because of the serious deficiencies noted in the own-children estimates derived from the 1976 PNAD, and because of the weakness of the P/F estimates prior to 1970.

It should also be noted that according to Table 44, total fertility for Brazil as a whole shows a tendency to decline even as early as 1955-60. However, except for Regions 1 and 2 where a fairly small decline was incorporated in the selected estimates, and for the emergence of Region 6, the total fertility rates for all other regions were left unchanged. Thus, at least half of the relatively small reduction in total fertility observed from 1945-50 to 1955-60 is due to the internal redistribution of the population, rather than to changes in fertility at the regional level. By 1965-70, several regions were showing reductions in fertility, although most of them were still fairly small. Only during the period labeled 1971-76 do sharp reductions become evident in most regions.

Although there is reason to believe that the estimates presented in Table 44 are more reliable than those presented before for similar periods, the question as to their true reference date still remains unanswered. While fertility was changing very slowly (before 1965), a very accurate determination of such dates is probably not necessary, but for more recent periods it is of crucial importance.

To shed some light on this point, a fertility estimation method that produces estimates with a well-defined reference date even during periods of fertility change was applied to Brazilian data for the 1972-77 period. The method used allows intersurvey fertility to be estimated from data gathered by two surveys 5 years

Table 45 Estimation of Intersurvey Fertility, 1972(73)-77: Brazil

Age Group	1972-73 $P_1(i)$	1977 $P_2(i)$	$P(i,s)$	$\bar{f}(i,s)$	P/F	Adjusted $\bar{f}(i)$
15-19	0.1149	0.1138	0.1138	0.0483	1.15	0.0685
20-24	0.9196	0.8385	0.8374	0.1730	1.15	0.2097
25-29	2.3248	2.0247	1.9425	0.2013	1.13	0.2308
30-34	3.7354	3.3650	2.9827	0.1676	1.13	0.1876
35-39	4.8367	4.5325	3.7798	0.1184	1.14	0.1302
40-44	5.5230	5.1985	4.1416	0.0558	1.11	0.0574
45-49	5.8187	5.5765	4.1951	0.0124	1.08	0.0107
TF				3.8840		4.4746

apart (Zlotnik and Hill, 1981). In Brazil the 1972 and the 1977 PNADs could be used for such purposes. However, because the 1972 PNAD excludes Region 7 completely, it was decided to average its results with those recorded by the 1973 PNAD and use such an average as the starting point. The basic data used and the resulting adjusted fertility estimates are shown in Table 45. The near coincidence of the intersurvey estimate of total fertility (4.47) with that shown in Table 44 for 1971-76 suggests that the reference date of the latter is closer to 1976 than to 1971. On the basis of this evidence, the total fertility estimate adjusted for the exclusion of rural Region 7 (4.60) was assigned 1975.0 as reference date. This estimate, together with those presented in Table 44 for periods prior to 1971, were used as guidelines to derive a smooth series of revised total fertility estimates. They are presented in Table 46 and displayed as a dotted line in Figure 17.

A Revised Series of Age-Specific Fertility Estimates for Brazil as a Whole

The two sets of fertility estimates presented above included age-specific fertility schedules. It is widely recognized that fertility changes over time affect not only the level of fertility but also its pattern with respect to age. This section explores the changing patterns of age-specific fertility in Brazil as a whole.

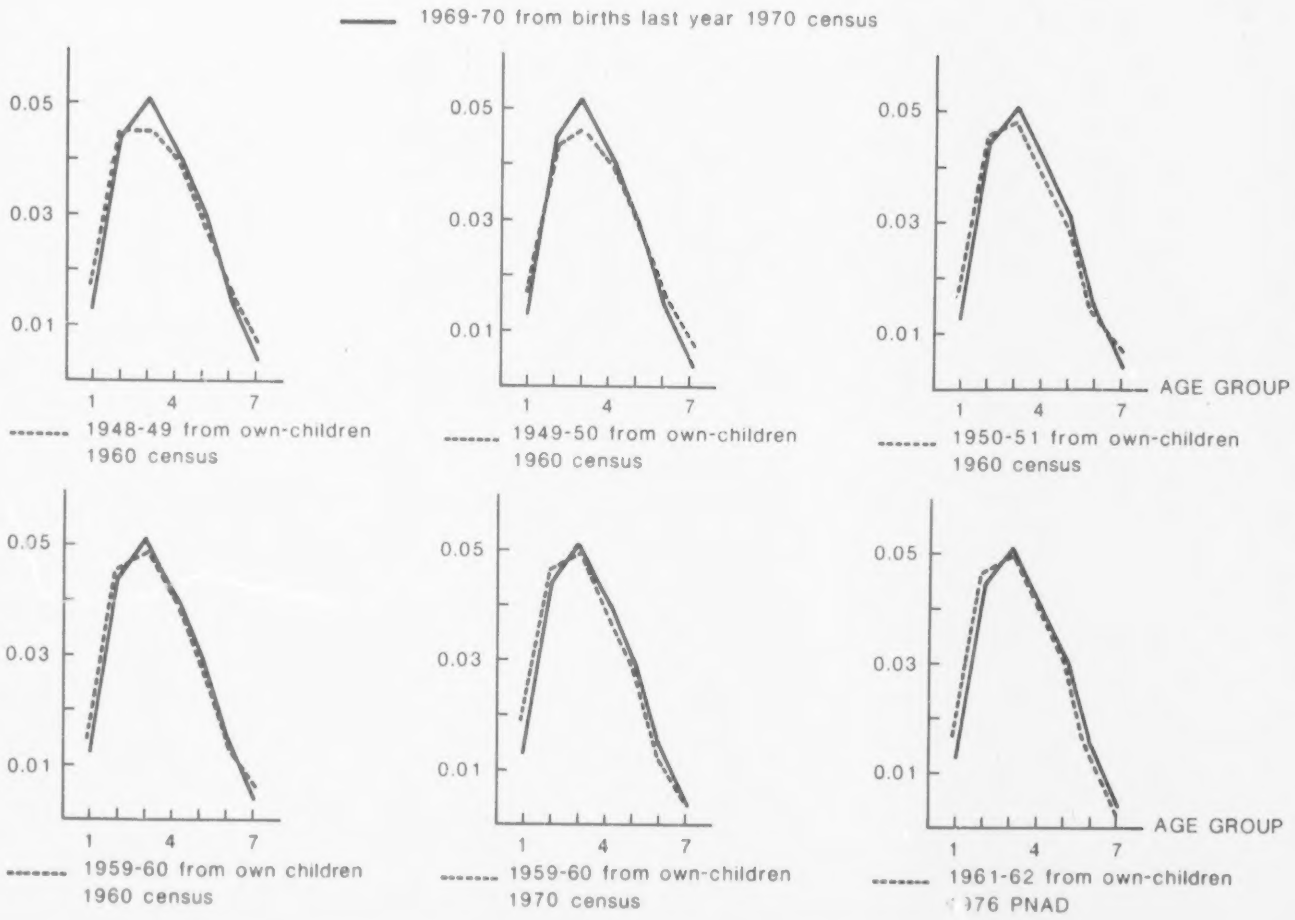
The graphs in Figure 24 compare the pattern of age-specific fertility for different periods as recorded by

TABLE 46 Selected Set of Total Fertility Estimates for the Country as a Whole, 1940-77: Brazil

Date	Total Fertility
1940.0	6.25
1942.5	6.25
1947.5	6.20
1952.5	6.10
1957.5	6.00
1962.5	5.90
1967.5	5.60
1972.5	5.00
1977.5	4.30

various sources. Because only the pattern is of interest, the age-specific fertility schedules have been rescaled so that their total fertility is one. To distinguish these rescaled schedules from those actually observed, they are denominated "fertility density functions".

The solid line in all the panels of Figure 24 plots the fertility density function derived from information on "births last year" recorded by the 1970 census. This schedule was selected as a basis for comparisons because, as explained earlier, it was assumed to have remained constant in shape during the 1950-70 period in order to be used in the application of the P/F ratio method to the 1950 and 1960 census data. Since information on the number of births occurring during the year preceding interview was not collected by these censuses, the only independent evidence regarding the pattern of fertility prior to 1960 must be obtained from own-children estimates. Thus, the first three panels of Figure 24 compare fertility density functions derived from own-children data and referring to periods around 1950 with the 1970 births-last-year pattern. If the own-children estimates are correct, it is evident that the 1970 schedule provides a fairly poor approximation to the true pattern of fertility during that period. It must be added, however, that although the own-children estimates presented refer to adjacent years, they are not as similar as one would


1969-70 from births last year 1970 census
0.05
0.03
0.01
1
4
7
1948-49 from own-children 1960 census
1949-50 from own-children 1960 census
1950-51 from own-children 1960 census
AGE GROUP
1959-60 from own children 1960 census
1959-60 from own-children 1970 census
1961-62 from own-children 1976 PNAD
AGE GROUP

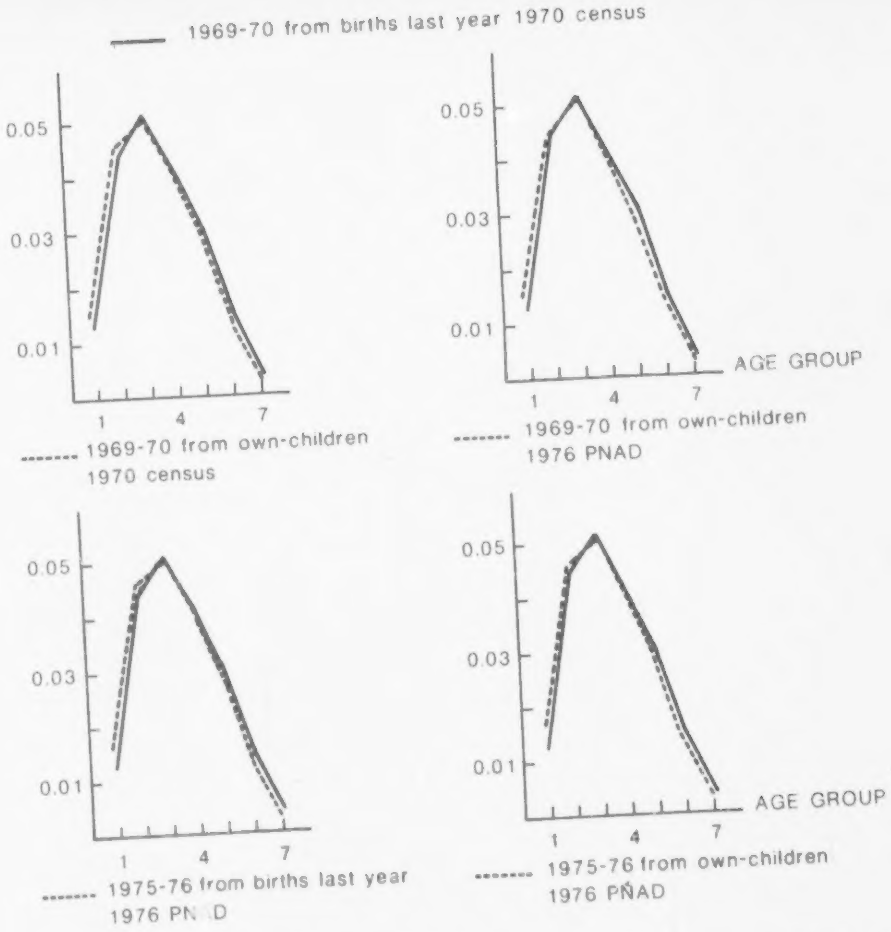


FIGURE 24 Comparison of Fertility Density Functions from Different Sources: Brazil

desire. The one estimated for 1949-50 appears to have the least distorted shape.

The next three panels of Figure 24 compare the 1970 "births last year" fertility density function with those referring approximately to the 1959-60 period, derived from own-children data of various sources. The agreement between the 1960 fertility densities and the 1970 one is better than that observed between the 1950 set and 1970. In addition, there is better agreement between the 1960 densities themselves, a reassuring fact.

The last four panels in Figure 24 compare the same 1969-70 fertility density function (derived from 1970 "births last year") with two own-children fertility densities referring to 1969-70 and with two densities for 1975-76. The very close agreement observed between the densities referring to 1969-70 is evidence of the relatively good quality of the data at hand, as is the fact that the 1975-76 densities deviate from that recorded in 1970 in the expected fashion: they are lower at older ages, as is typically the case when fertility has declined.

Using these comparisons as guidelines, "representative" fertility density functions for the periods 1949-50, 1959-60, 1969-70, and 1975-76 were selected. They are presented in Table 47, together with the α and β values that define model fertility density functions fitted to them within the Gompertz system (Brass, 1981). The selected densities are also plotted in Figure 25 to show that their evolution through time is acceptable; their shape has tended to become more "peaked" due to a reduction in the contribution of older age groups. The fitted values are displayed graphically in Figure 26.

Although the evolution of fertility patterns according to the fitted densities has been generally quite similar to that suggested by the observed ones, there are noticeable differences between the two. The fitted densities evolve fairly smoothly, keeping the essential pattern of the middle age range (age groups 2, 3, and 4, i.e., 20-24, 25-29, and 30-34) virtually unchanged; they also show a slower and more general (in terms of age groups affected) decline at older ages. This behavior contrasts with the somewhat ragged evolution of the shape of the observed densities in the middle age range, and with the sharper decline they display at the oldest age group (7 or 45-49). In addition, it is clear that the values they attain at this age group are substantially higher than those attained by the fitted densities. Given that most of the

TABLE 47 Selected Set of Fertility Density Functions for the Country as a Whole: Brazil

Age Group	1949-50[a]	1959-60[b]	1969-70[c]	1975-76[d]
15-19	0.0168	0.0146	0.0149	0.0165
20-24	0.0428	0.0455	0.0458	0.0463
25-29	0.0465	0.0485	0.0507	0.0504
30-34	0.0405	0.0419	0.0416	0.0421
35-39	0.0298	0.0300	0.0303	0.0291
40-44	0.0157	0.0138	0.0134	0.0132
45-49	0.0079	0.0058	0.0033	0.0024
α	0.2302	0.2356	0.2154	0.1766
β	-0.9567	-1.0201	-1.0472	-1.0520

[a] 1960 own children.
[b] 1960 own children.
[c] 1970 own children.
[c] 1976 births last year.

observed densities were derived from own-children data, the discrepancies noticed at older age groups are not surprising. They are almost certainly due to the typical biases affecting the basic data, such as those caused by the erroneous assignment of young children to their grandmothers. It would appear, therefore, that in spite of the discrepancies noticed, the fitted densities are to be preferred to the observed, since they "correct" some of the biases present in the latter.

The availability of α and β parameters defining acceptable fertility density functions for specified periods allows us to derive appropriate densities for other points in time by interpolating between the α and β values. This procedure was followed to obtain α and β estimates referring approximately to the middle of each quinquennial period 1945-49, 1950-54, ..., 1975-80. They are shown in Table 48. Given these estimates, the use of the Gompertz system of fertility models permits the estimation of the corresponding density functions which, coupled with the total fertility estimates of Table 46, yield the age-specific fertility schedules also presented in Table 48.

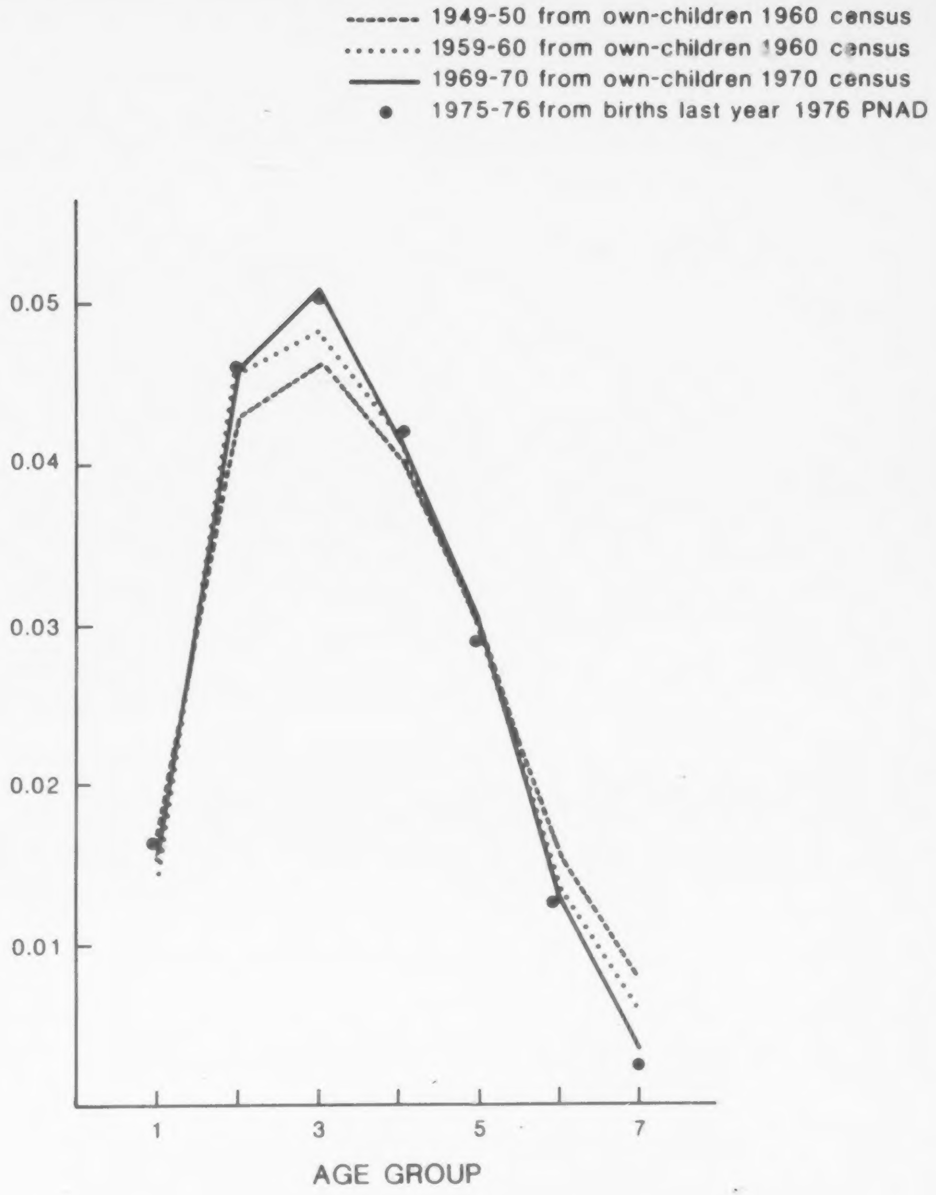


FIGURE 25 Graphic Comparison of the Selected Set of Fertility Density Functions: Brazil

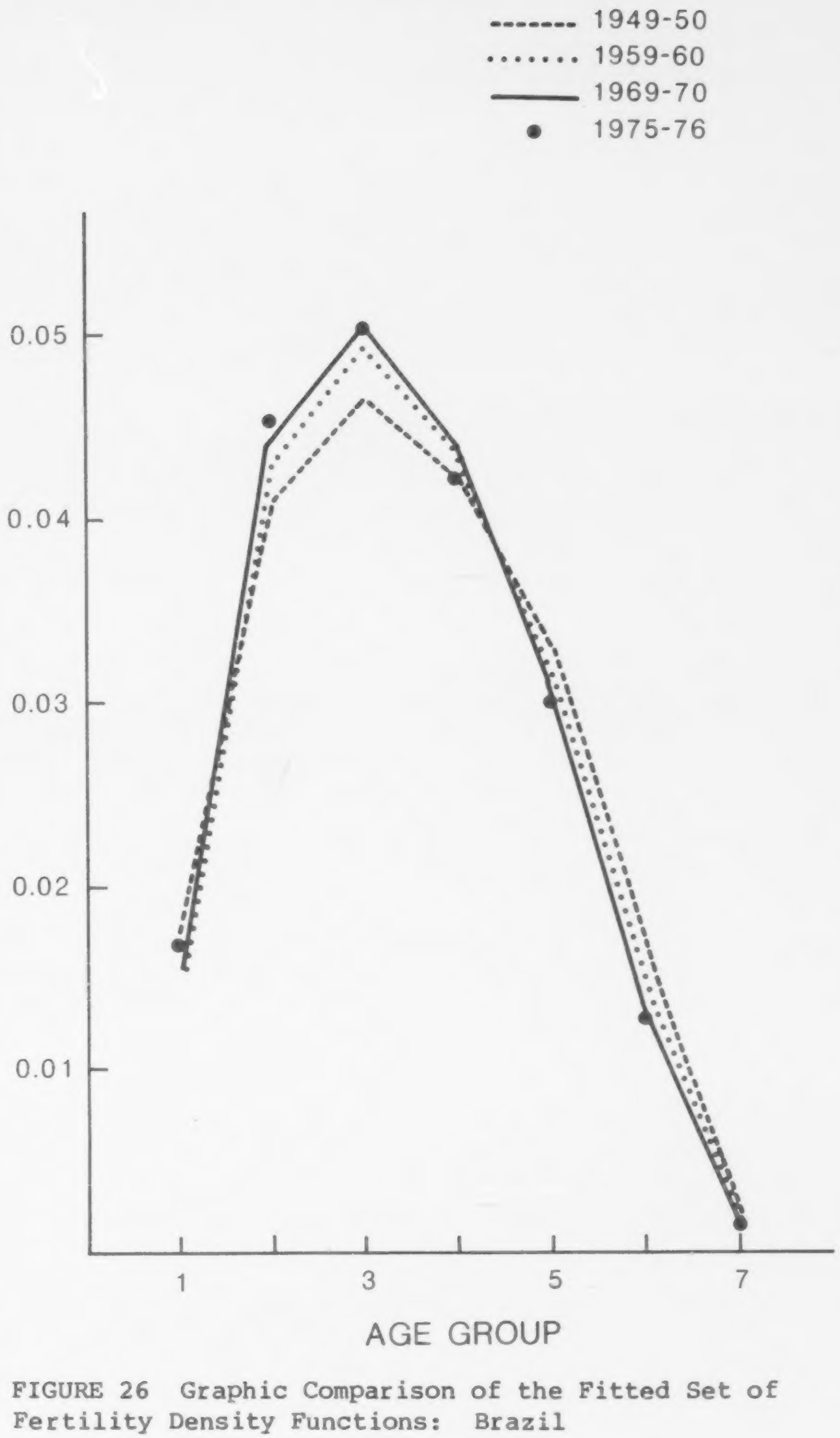


FIGURE 26 Graphic Comparison of the Fitted Set of Fertility Density Functions: Brazil

TABLE 48 Final Set of Estimated Age-Specific Fertility Schedules for the Country as a Whole, 1940-80: Brazil

Age Group	Reference Period							
	1940-44	1945-49	1950-54	1955-59	1960-64	1965-69	1970-74	1975-79
15-19	0.1091	0.1082	0.1034	0.0957	0.0911	0.0866	0.0801	0.0740
20-24	0.2569	0.2549	0.2535	0.2545	0.2548	0.2459	0.2241	0.1975
25-29	0.2903	0.2879	0.2877	0.2915	0.2926	0.2808	0.2520	0.2164
30-34	0.2643	0.2622	0.2600	0.2594	0.2568	0.2434	0.2155	0.1821
35-39	0.2081	0.2065	0.2016	0.1951	0.1885	0.1758	0.1535	0.1282
40-44	0.1056	0.1048	0.0998	0.0919	0.0856	0.0781	0.0670	0.0554
45-49	0.0157	0.0156	0.0142	0.0121	0.0106	0.0094	0.0078	0.0064
TF		6.2000	6.1000	6.0000	5.9000	5.6000	5.0000	4.3000
	0.2302	0.2302	0.2315	0.2342	0.2309	0.2208	0.2008	0.1695
	-0.9567	-0.9567	-0.9723	-1.0034	-1.0264	-1.0400	-1.0490	-1.0529

CONCLUSION

In this chapter, a series of age-specific fertility estimates covering the 1940-80 period has been derived for Brazil as a whole. Consideration of fertility estimates at the regional level has been essential in this derivation, since certain biases could be deleted or corrected, to the degree possible, only at the regional level. However, although a series of indicators of fertility levels at the regional level was selected (see Table 44), no attempt was made to transform them into a consistent series of age-specific fertility estimates for the period considered. Such a task is beyond the scope of this report. However, all the elements required to carry it out have been presented. The implications that the fertility estimates derived have in terms of population growth are analyzed in some detail in the following chapter.

CHAPTER 4

POPULATION GROWTH

COMPONENTS OF GROWTH

In order to derive measures of the components of growth of the Brazilian population from the fertility and mortality schedules derived in previous chapters it is necessary to use a starting or baseline population classified by age and sex. Because most of the estimates obtained refer to the 1940-70 period, the starting date was fixed at 1940. For that year, the 1940 census provides an age and sex distribution for the enumerated population. However, the use of such distribution for the purpose at hand is not recommended because of the age-reporting and coverage errors that affect it. One possible strategy to reduce the effects of errors is to smooth the reported age distribution by means of statistical techniques. Another, somewhat more satisfactory when differential coverage by age is likely to affect the enumerated population, is to use a model age distribution that approximates the observed. However, age distributions derived via models will, in general, not reflect any deviant, though real, characteristics of the observed population. In particular, if the age distribution of a stable population were used to approximate the observed, it would probably fail to reflect changes in the age structure brought about by fertility fluctuations, long-term mortality changes and migration. Yet, given the evolution of the Brazilian population during the late nineteenth and early twentieth centuries, it can be argued that the effects of mortality change and migration are likely to cancel each other out because declining mortality leads, in general, to a younger population, while the influx of adults through immigration will tend to counterbalance the increasing weight of the younger age groups. Therefore, even though a stable population generated according to the mortality level prevalent around 1940 would, strictly speaking, have an older age distribution than the native population which has been subject to a long-term mortality decline, it may nevertheless approximate well the actual population which was subject not only to declining mortality, but also to substantial influxes of migrants prior to 1900. This expectation was corroborated by comparisons between the age distributions of, on the one hand, the native-born Brazilian population and the total population enumerated in 1940 and, on the other, the stable population generated on the basis of the fertility and mortality estimates for 1940 already presented. For this reason, the stable age distribution was used to construct the baseline population for 1940, which was then projected forward according to the fertility and mortality estimated for different periods to yield estimates of the population's size and age structure at different points in time.

Tables 49 and 50 show some of the results obtained when this procedure was applied to the Brazilian data. Specifically, it displays estimated birth and death rates and rates of natural increase for each sex for each five-year period since 1940. Table 50 shows the estimated population at the time of the different censuses and the corresponding estimates of completeness of enumeration. Notice that the 1940 female population was used to determine the size of the baseline population, and thus its completeness of enumeration is 1.0. Such a choice can be partly justified by the fact that the observed sex ratios of the population are too low (see Table 5), suggesting that, overall, males were less accurately enumerated than females. This assumption is reflected in the completeness estimates obtained, which are certainly lower for males than for females. Obviously, these estimates cannot and should not be interpreted in an absolute fashion: only their differences convey information about the relative completeness of enumeration attained by one census with respect to another. Viewed in this way the three series of completeness estimates presented in Table 50 reveal that the 1950 census achieved a lower completeness of coverage than the rest and that the completeness of coverage attained by all the other censuses is more or less the same.

To the extent in which the constructed population evolves in ways similar to the one observed or that comparisons between the two corroborate deficiencies that

TABLE 49 Estimated Quinquennial Birth Rates, Death Rates, and Rates of Natural Increase, by Sex, 1940-80: Brazil

	Male			Female			Both Sexes		
Period	Birth Rate	Death Rate	Rate of Natural Increase	Birth Rate	Death Rate	Rate of Natural Increase	Birth Rate	Death Rate	Rate of Natural Increase
1940	.0450	.0195	.0255	.0436	.0181	.0255	.0443	.0188	.0255
1940-44	.0449	.0190	.0260	.0435	.0176	.0259	.0442	.0183	.0259
1945-49	.0445	.0178	.0267	.0431	.0165	.0266	.0438	.0172	.0266
1950-54	.0437	.0166	.0271	.0423	.0153	.0270	.0430	.0160	.0270
1955-59	.0431	.0155	.0276	.0417	.0142	.0275	.0424	.0148	.0276
1960-64	.0425	.0141	.0283	.0411	.0129	.0283	.0418	.0135	.0283
1965-69	.0405	.0125	.0280	.0393	.0113	.0280	.0399	.0119	.0280
1970-74	.0367	.0107	.0260	.0356	.0096	.0260	.0362	.0102	.0260
1975-79	.0325	.0091	.0234	.0315	.0082	.0234	.0320	.0086	.0234

TABLE 50 Estimated Population (in thousands) at the Time of the Censuses and Estimated Completeness of Enumeration, 1940-80: Brazil

	Estimated Count			Completeness of Enumeration[a]		
Year	Male	Female	Both Sexes	Male	Female	Both Sexes
1940	20,874	20,626	41,500	0.988	1.000	0.994
1950	27,054	26,721	53,775	0.957	0.976	0.967
1960	35,747	35,294	71,041	0.981	0.995	0.988
1970	47,342	46,735	94,077	0.979	1.002	0.990
1980	60,461	59,673	120,134	0.978	1.005	0.991

Note: The sex ratio at birth used is 1.045.

[a] Relative to the completeness of coverage of females in 1940.

had already been noted in the observed population, the estimated population helps to validate the acceptability of the mortality and fertility estimates used to derive it. For example, in the chapter on mortality, the estimation of mortality levels on the basis of intercensal comparisons led us to conclude that the 1950 census was more deficient than the rest with respect to census coverage. By eliminating it from the series of census counts, a revised set of intercensal growth rates was derived (see Table 22). Table 51 displays a comparable set for the reconstructed population. Examination of the two sets shows that the agreement between them is acceptable. In addition, the 1940 growth rates presented in Table 24 almost coincide with those calculated for the stable population generated on the basis of the estimated fertility and mortality schedules (see Table 49). The results of these comparisons are encouraging, since they do not reveal the existence of serious biases in the reconstructed population.

For this reason, it seems appropriate to adopt the estimates presented in Table 49 as trustworthy indicators of the evolution of the Brazilian population since 1940. According to such estimates the birth rate in Brazil would have declined from 44.3 births per 1,000 population in 1940 to some 32 births per 1,000 in 1975-79, a reduction of approximately 28 percent; whereas the death rate declined by more than 50 percent during the same period, changing from 18.8 deaths per 1,000 in 1940 to some 8.6 deaths per 1,000 in 1975-79. The combination of these two downward trends in the main components of population growth led to an inverted U-shaped trend in the rate of natural increase: it increased steadily from 1940 to 1960-64, only to decline thereafter at an ever-increasing

TABLE 51 Estimated Intercensal Rates of Natural Increase, 1940-80: Brazil

Period	Male	Female
1940-50	.0263	.0263
1950-60	.0273	.0273
1960-70	.0282	.0281
1970-80	.0249	.0247

rate. Thus, by the latter half of the 1970-79 decade, Brazil's population was growing more slowly than it ever had since 1940.

One cannot conclude this brief overview on population growth without making some reference to its third determinant: international migration. Almost no mention has been made of this component in the body of this report, mainly because it is particularly difficult to obtain reliable estimates of its magnitude (see footnote on page 93). Thus, although in strict terms the Brazilian population has not been closed to international migration during the period considered, it has been implicitly assumed throughout this report that levels of net international migration have been almost negligible, an assumption that is validated to some extent by the good fit observed between the reconstructed population and the one observed (see Table 50).

AGE DISTRIBUTION OF THE POPULATION

Table 52 presents the estimated age distributions of the Brazilian population at approximately the dates of the different censuses. Comparisons between the estimated and the observed age distributions are of special interest because they may shed light on the pattern and magnitude of the errors affecting the latter, and on the deviant, though possibly real, characteristics of the Brazilian population.

Figure 27 presents a graphic comparison of the observed and the estimated age distributions. Specifically, the values plotted in Figure 27 are the proportionate deviations of the expected proportion in age group x to x + 4 from the observed, expressed on a percentage basis or, in mathematical terms:

$${}_5R_x = 100\,\frac{{}_5C_x^e - {}_5C_x^o}{{}_5C_x^e}$$

where ${}_5C_x$ is the proportion of the population aged x to x + 4, and the superindexes o and e indicate, respectively, the observed and estimated quantities. Thus, a positive value of ${}_5R_x$ implies that ${}_5C_x^o < {}_5C_x^e$ and the inverse relationship, ${}_5C_x^o > {}_5C_x^e$ is implied by a negative value of ${}_5R_x$.

TABLE 52 Estimated Age Distributions at the Time of the Censuses, 1940-80: Brazil

Age Group	1940	1950	1960	1970	1980
Male					
0-4	.1715	.1719	.1698	.1649	.1392
5-9	.1400	.1408	.1406	.1416	.1330
10-14	.1206	.1203	.1211	.1206	.1239
15-19	.1040	.1037	.1038	.1036	.1089
20-24	.0892	.0890	.0885	.0890	.0925
25-29	.0759	.0757	.0755	.0757	.0789
30-34	.0646	.0641	.0642	.0641	.0675
35-39	.0546	.0541	.0542	.0543	.0571
40-44	.0455	.0453	.0453	.0457	.0479
45-49	.0371	.0375	.0374	.0379	.0400
50-54	.0296	.0302	.0304	.0308	.0328
55-59	.0233	.0235	.0240	.0244	.0261
60-64	.0177	.0174	.0181	.0186	.0200
65-69	.0126	.0122	.0126	.0132	.0144
70-74	.0079	.0079	.0080	.0085	.0095
75-79	.0041	.0043	.0044	.0047	.0054
80+	.0019	.0021	.0023	.0024	.0029
Female					
0-4	.1688	.1692	.1670	.1622	.1362
5-9	.1380	.1388	.1386	.1394	.1308
10-14	.1188	.1186	.1194	.1190	.1223
15-19	.1024	.1022	.1025	.1023	.1075
20-24	.0878	.0877	.0874	.0881	.0916
25-29	.0749	.0747	.0746	.0751	.0783
30-34	.0639	.0634	.0635	.0636	.0671
35-39	.0542	.0537	.0537	.0539	.0569
40-44	.0455	.0453	.0452	.0456	.0479
45-49	.0377	.0380	.0378	.0381	.0402
50-54	.0308	.0313	.0314	.0315	.0334
55-59	.0249	.0251	.0255	.0256	.0272
60-64	.0197	.0193	.0199	.0203	.0216
65-69	.0146	.0142	.0146	.0152	.0163
70-74	.0098	.0097	.0098	.0104	.0114
75-79	.0055	.0057	.0058	.0062	.0070
80+	.0028	.0031	.0033	.0036	.0043

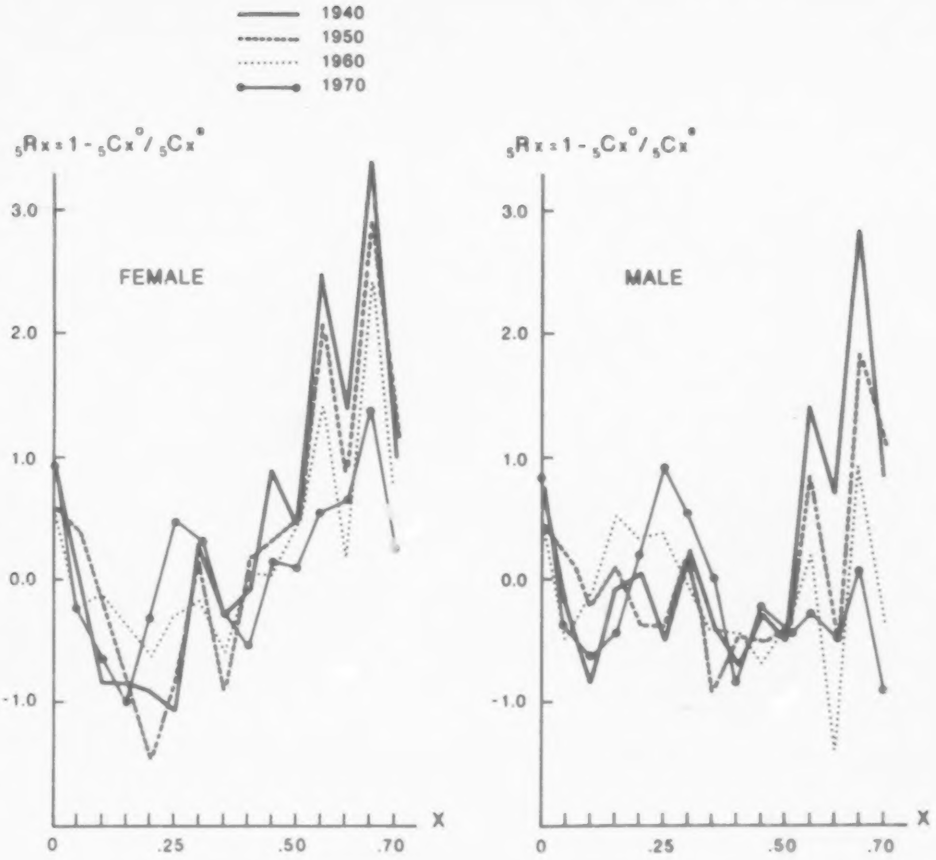


FIGURE 27 Comparison of the Observed and Estimated Age Distribution, 1940-70: Brazil

The effects of international migration have been considered. The little evidence available suggests that migration to Brazil during the period 1940-70 was almost negligible. Also, the projection fits better the whole population than the native-born population taken separately, perhaps because of roughly equal migration into and out of Brazil.

Examination of the plots in Figure 27 reveals that the discrepancies between the observed and the estimated age distributions are greater among females than among males, and that while the pattern of age-reporting errors for females has remained fairly constant from one census to the next, the deviation pattern observed for males in 1970 is quite different from that observed in 1940.

In particular, all the female age distributions currently available appear to have a deficit of females above age 45, while, on average, there appears to have been an excessive proportion reported in the 15-44 age range (although in 1970 the recorded excess is probably small). In contrast, for males an excessive proportion at older ages is noticed only in 1940 (above age 55) and somewhat in 1950 (above age 65), since for later censuses the proportion of males over age 40 appears to have been overreported, if only to a relatively small extent (some 4 or 5 percent). In addition, in 1960 and 1970, deficits are noticed at the adult ages (15-29 and 20-34, respectively).

Although not shown graphically, a comparison of the cumulated age distributions (the proportions under each age x, C(x-)) reveals that remarkably good fits are attained in the case of males (the proportional deviations of the observed over the estimated proportions C(x-) being generally below 2 percent above age 15), while slightly less satisfactory ones are obtained in the case of females. However, for both males and females the worst fits occur at younger ages, with the observed proportion under age 5 being underreported by as much as 10 percent in some instances. Particularly worrisome is the poor fit attained between the observed and the estimated ${}_5C_0$ in 1970 (see Figure 27) since it may imply that fertility levels for 1960-70 are overestimated. Yet, one must point out that the 1970 level of undercount at young ages implied by our fertility estimates is fairly similar to that estimated for 1940, where there is less uncertainty about the estimated fertility levels, so that it is not, in and of itself, an extraordinary outcome.

Thus, although the perfect agreement that would be desired between observed and estimated age distributions was not attained, the discrepancies observed are more likely to be caused by errors in the basic data than by the gross inadequacy of the estimated fertility and mortality levels and trends. This statement, however, should not be interpreted as meaning that the latter are free from error or that they provide completely accurate measures of the components of growth of the Brazilian population. Rather, they constitute a consistent and smooth set of estimators which help us understand the evolution of this population by approximating its most reliable features.

APPENDIX: ESTIMATED LIFE TABLES

ESTIMATED LIFE TABLES BY SEX, 1940: BRAZIL
FEMALES

AGE X	l(X)	L(X)	T(X)	E(X)
0	1.00000	0.912523	47.01434	47.014
1	0.86542	3.209517	46.10182	53.271
5	0.77409	3.824325	42.69232	55.410
10	0.75564	3.739597	39.06801	51.702
15	0.74020	3.666598	35.32841	47.728
20	0.72644	3.578174	31.66182	43.585
25	0.70483	3.464823	28.08365	39.845
30	0.68110	3.340523	24.61884	36.146
35	0.65511	3.205624	21.27832	32.481
40	0.62714	3.060972	18.07271	28.818
45	0.59725	2.904148	15.01174	25.135
50	0.56441	2.718773	12.10760	21.452
55	0.52310	2.488575	9.38882	17.948
60	0.47233	2.193424	6.90025	14.609
65	0.40504	1.821975	4.70682	11.621
70	0.32375	1.380000	2.88485	8.911
75	0.22825	0.901775	1.50485	6.593
80	0.13246	0.603074	0.60307	4.553

ESTIMATED LIFE TABLES BY SEX, 1940: BRAZIL
MALES

AGE X	l(X)	L(X)	T(X)	E(X)
0	1.00000	0.900049	44.50226	44.502
1	0.85082	3.154327	43.60222	51.247
5	0.76062	3.757324	40.44789	53.178
10	0.74231	3.675499	36.69057	49.428
15	0.72789	3.607249	33.01508	45.357
20	0.71501	3.517823	29.40784	41.129
25	0.69212	3.399873	25.89001	37.407
30	0.66763	3.271923	22.49014	33.676
35	0.64094	3.128200	19.21823	29.984
40	0.61034	2.961574	16.09004	26.362
45	0.57429	2.766800	13.12847	22.860
50	0.53243	2.533798	10.36167	19.461
55	0.48109	2.252899	7.82787	16.271
60	0.42007	1.914124	5.57497	13.272
65	0.34558	1.517474	3.66085	10.593
70	0.26141	1.085649	2.14337	8.199
75	0.17285	0.662125	1.05772	6.119
80	0.09200	0.395600	0.39560	4.300

ESTIMATED LIFE TABLES BY SEX, 1950: BRAZIL FEMALES

AGE X	1(X)	L(X)	T(X)	E(X)
0	1.00000	0.919933	50.25746	50.257
1	0.87682	3.292832	49.33754	56.269
5	0.79915	3.956348	46.04471	57.617
10	0.78339	3.884649	42.08836	53.726
15	0.77047	3.822675	38.20372	49.585
20	0.75660	3.745723	34.38106	45.322
25	0.73969	3.646023	30.63535	41.416
30	0.71872	3.535974	26.98933	37.552
35	0.69567	3.415575	23.45337	33.713
40	0.67056	3.284299	20.03780	29.882
45	0.64316	3.138099	16.75351	26.049
50	0.61208	2.960949	13.61541	22.244
55	0.57230	2.736249	10.65446	13.617
60	0.52220	2.441999	7.91821	15.163
65	0.45460	2.061275	5.47622	12.046
70	0.36991	1.592475	3.41494	9.232
75	0.26703	1.067325	1.82247	6.824
80	0.15985	0.755141	0.75514	4.724

ESTIMATED LIFE TABLES BY SEX, 1950: BRAZIL MALES

AGE X	1(X)	L(X)	T(X)	E(X)
0	1.00000	0.908351	47.60881	47.609
1	0.86321	3.239133	46.70047	54.101
5	0.78578	3.889448	43.46135	55.310
10	0.77000	3.818874	39.57191	51.392
15	0.75755	3.759174	35.75305	47.196
20	0.74612	3.680398	31.99388	42.880
25	0.72604	3.576999	28.31349	38.997
30	0.70476	3.464775	24.73650	35.099
35	0.68115	3.337450	21.27173	31.229
40	0.65383	3.186975	17.93428	27.430
45	0.62096	3.005848	14.74731	23.749
50	0.58138	2.781898	11.74146	20.196
55	0.53138	2.502899	8.95956	16.861
60	0.46978	2.156000	6.45666	13.744
65	0.39262	1.739275	4.30066	10.954
70	0.30269	1.269199	2.56239	8.465
75	0.20499	0.794150	1.29319	6.309
80	0.11267	0.499037	0.49904	4.429

ESTIMATED LIFE TABLES BY SEX, 1960: BRAZIL
FEMALES

AGE X	l(X)	L(X)	T(X)	E(X)
0	1.00000	0.927083	53.89020	53.890
1	0.88782	3.372284	52.96312	59.655
5	0.82299	4.081947	49.59084	60.257
10	0.80979	4.023048	45.50890	56.198
15	0.79943	3.973274	41.48586	51.894
20	0.78938	3.912249	37.51259	47.492
25	0.77502	3.833199	33.60034	43.354
30	0.75826	3.744399	29.76715	39.257
35	0.73950	3.644374	26.02277	35.190
40	0.71845	3.532497	22.37790	31.147
45	0.69455	3.401723	18.84541	27.133
50	0.66614	3.237400	15.44370	23.184
55	0.62882	3.022973	12.20630	19.411
60	0.58037	2.734673	9.18333	15.823
65	0.51350	2.349150	6.44866	12.558
70	0.42616	1.855000	4.09951	9.620
75	0.31584	1.278074	2.24451	7.106
80	0.19539	0.966435	0.96644	4.946

ESTIMATED LIFE TABLES BY SEX, 1960: BRAZIL
MALES

AGE X	l(X)	L(X)	T(X)	E(X)
0	1.00000	0.916371	50.93271	50.933
1	0.87518	3.320105	50.01634	57.150
5	0.80974	4.015247	46.69624	57.668
10	0.79636	3.955674	42.68100	53.595
15	0.78591	3.905098	38.72533	49.274
20	0.77613	3.838749	34.82024	44.864
25	0.75937	3.752699	30.98149	40.799
30	0.74171	3.659374	27.22881	36.711
35	0.72204	3.552275	23.56944	32.643
40	0.69887	3.422475	20.01718	28.642
45	0.67012	3.259999	16.59471	24.764
50	0.63388	3.050599	13.33473	21.037
55	0.58636	2.778974	10.28413	17.539
60	0.52523	2.429025	7.50515	14.289
65	0.44638	1.993924	5.07613	11.372
70	0.35119	1.487949	3.08220	8.776
75	0.24399	0.956925	1.59425	6.534
80	0.13878	0.637330	0.63733	4.592

ESTIMATED LIFE TABLES BY SEX, 1970: BRAZIL
FEMALES

AGE X	1(X)	L(X)	T(X)	E(X)
0	1.00000	0.937932	59.24760	59.248
1	0.90735	3.519183	58.30968	64.228
5	0.86571	4.306499	54.79050	63.290
10	0.85689	4.267399	50.48401	58.915
15	0.85007	4.233348	46.21661	54.368
20	0.84327	4.188223	41.98328	49.786
25	0.83202	4.127798	37.79506	45.426
30	0.81910	4.058673	33.66727	41.103
35	0.80437	3.979098	29.60860	36.810
40	0.78727	3.885347	25.62950	32.555
45	0.76687	3.770124	21.74416	28.354
50	0.74118	3.618898	17.97404	24.251
55	0.70638	3.414874	14.35515	20.322
60	0.65957	3.132097	10.94028	16.587
65	0.59327	2.739274	7.80818	13.161
70	0.50244	2.212549	5.06891	10.089
75	0.38258	1.568850	2.85636	7.466
80	0.24496	1.287509	1.28751	5.256

ESTIMATED LIFE TABLES BY SEX, 1970: BRAZIL
MALES

AGE X	1(X)	L(X)	T(X)	E(X)
0	1.00000	0.930970	55.92941	55.929
1	0.89697	3.465721	54.99844	61.316
5	0.85271	4.240699	51.53273	60.434
10	0.84357	4.199073	47.29204	56.062
15	0.83606	4.160897	43.09297	51.543
20	0.82830	4.107299	38.93206	47.002
25	0.81462	4.037499	34.82480	42.750
30	0.80038	3.962123	30.78731	38.466
35	0.78447	3.874523	26.82520	34.195
40	0.76534	3.765149	22.95068	29.988
45	0.74072	3.621399	19.18555	25.901
50	0.70784	3.426499	15.56415	21.983
55	0.66276	3.161222	12.13765	18.314
60	0.60173	2.805149	8.97643	14.918
65	0.52033	2.346100	6.17128	11.860
70	0.41811	1.791175	3.82518	9.149
75	0.29836	1.185575	2.03400	6.817
80	0.17587	0.848430	0.84843	4.824

ESTIMATED LIFE TABLES BY SEX, 1975: BRAZIL
FEMALES

AGE X	l(X)	L(X)	T(X)	E(X)
0	1.00000	0.942594	61.99956	62.000
1	0.91870	3.591419	61.05693	66.460
5	0.88718	4.418874	57.46556	64.773
10	0.88037	4.388824	53.04669	60.255
15	0.87516	4.362073	48.65788	55.599
20	0.86967	4.324698	44.29582	50.934
25	0.86021	4.273498	39.97113	46.467
30	0.84919	4.214198	35.69765	42.037
35	0.83649	4.144850	31.48346	37.638
40	0.82145	4.061098	27.33862	33.281
45	0.80299	3.954749	23.27753	28.989
50	0.77891	3.811596	19.32278	24.807
55	0.74573	3.614823	15.51120	20.800
60	0.70020	3.337598	11.89638	16.990
65	0.63484	2.944424	8.55878	13.482
70	0.54293	2.404525	5.61435	10.341
75	0.41888	1.729025	3.20983	7.663
80	0.27273	1.480804	1.48080	5.430

ESTIMATED LIFE TABLES BY SEX, 1975: BRAZIL
MALES

AGE X	l(X)	L(X)	T(X)	E(X)
0	1.00000	0.936706	58.65576	58.656
1	0.90907	3.548739	57.71907	63.492
5	0.87616	4.363098	54.17033	61.827
10	0.86908	4.330373	49.80724	57.310
15	0.86307	4.298598	45.47687	52.692
20	0.85637	4.251549	41.17828	48.085
25	0.84425	4.189949	36.92674	43.739
30	0.83173	4.123699	32.73680	39.360
35	0.81775	4.046225	28.61311	34.990
40	0.80074	3.947673	24.56689	30.680
45	0.77833	3.814249	20.61923	26.492
50	0.74737	3.628025	16.80499	22.486
55	0.70384	3.367674	13.17697	18.722
60	0.64323	3.010399	9.80930	15.250
65	0.56093	2.540848	6.79890	12.121
70	0.45541	1.961675	4.25805	9.350
75	0.32926	1.316899	2.29638	6.974
80	0.19750	0.979476	0.97948	4.959

REFERENCES

Arretx, C. (1973) Estimacion de la Fecundidad a base de informacion sobre hijos nacidos vivos, recogida en censos sucesivos. Notas de Poblacion 1(3):7-16.

Brass, W. (1964) Uses of census and survey data for the estimation of vital rates. African Seminar on Vital Statistics. Addis Ababa: United Nations Economic Commission for Africa.

Brass, W. (1975) Methods for Estimating Fertility and Mortality from Limited and Defective Data. Chapel Hill, N.C.: Laboratories for Population Statistics.

Brass, W. (1981) The Use of the Gompertz relational model to estimate fertility. Pp. 345-362 in Proceeding of the International Conference of the IUSSP, Manila, 1981. Liege, Belgium: International Union for the Scientific Study of Population.

Brass, W., and K. Hill (1973) Estimating adult mortality from orphanhood. Proceedings of the International Population Conference, Vol. 3. Liege, Belgium: International Union for the Scientific Study of Population.

Brass, W., and E. A. Bamgboye (1981) The time location of reports of survivorship: Estimates for maternal and parental orphanhood and the ever-widowed. Working Paper No. 81-1. London: Centre for Population Studies, London School of Hygiene and Tropical Medicine.

Carvalho, J. A. M. (1974) Regional trends in fertility and mortality in Brazil. Population Studies 28(3):401-421.

CICRED (1975) La Population du Bresil. Paris: Imprimerie Louis-Jean.

Cho, L. J. (1973) The own-children approach to fertility estimation: An elaboration. In Proceedings of the

International Population Conference, Vol. 2. Liege, Belgium: International Union for the Scientific Study of Population.

Coale, A. J., and P. Demeny (1966) *Regional Model Life Tables and Stable Populations*. Princeton, N.J.: Princeton University Press.

Fundacao IBGE (1956) *VI Recenseamento Geral do Brasil - 1950 - Censo Demografico* (Brazil and State Volumes). Rio de Janeiro: Fundacao IBGE.

Fundacao IBGE (1967-77) *Censo Demografico de 1960* (Brazil and State Volumes). Rio de Janeiro: Fundacao IBGE.

Fundacao IBGE (1973) *Censo Demografico, 1970*. (Brazil and State Volumes). Rio de Janeiro: Fundacao IBGE.

Fundacao IBGE (1981) *Sinopse Preliminar do Censo Demografico. IX Recenseamento Geral do Brasil - 1980*. Rio de Janeiro: Fundacao IBGE.

Leite, V. (1973) Observacoes sobre a declaracao de filhos tidos nascidos mortos. *Revista Brasileira de Estatistica* 34(135):417-424.

Medeiros-Frias, L. A., and P. Rodrigues (1979) A incidencia dos nascidos mortos no Brasil. Mimeo. Unpublished.

Melo-Moreira, M., L. M. da Silva, and R. T. McLaughlin (1978) *Brazil: Country Profile*. New York, N.Y.: The Population Council.

Merrick, T. W., and D. H. Graham (1979) *Population and Economic Development in Brazil*. Baltimore, Md.: The Johns Hopkins University Press.

Mortara, G. (1947) Determinacao da fecundidade femenina, segundo a idade conforme o censo de 1940, e aplicacoes ao calculo da taxa de natalidade, da tabua de fecundidade e do coeficiente de reproducao para a populacao do Brasil. *Revista Brasileira de Estatistica* 8(30/31):255-284.

Mortara, G. (1970a) A fecundidade da mulher e a sobrevivencia dos filhos no Brasil, segundo o censo de 1950. *Contribucoes para o Estudo da Demografia no Brasil*. Rio de Janeiro: Fundacao IBGE.

Mortara, G. (1970b) *Contribucoes para o Estudo da Demografia no Brasil*.(Collected Papers). Rio de Janeiro: Fundacao IBGE.

Preston, S., A. J. Coale, M. Weinstein, and T. J. Trussell (1980) Estimating the completeness of reporting of adult deaths in populations that are approximately stable. *Population Index* 46(2):179-202.

United Nations, Department of Economic and Social Affairs (1967) Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data. Population Studies No. 42. New York: United Nations.

United Nations, Department of Economic and Social Affairs (1983) Manual X: Indirect Techniques for Demographic Estimation. New York: United Nations.

Zlotnik, H., and K. Hill (1981) The use of hypothetical cohorts in estimating demographic parameters under conditions of changing fertility and mortality. Demography 18(1):103-122.

GLOSSARY

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by ${}_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol $_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by l(x). The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by e(x); the probability of surviving from each age x to age x + n, denoted by $_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age x + n, denoted by $_nL_x$ (also equivalent to the population aged x, x + n in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is 1/2 ln[p/(1 - p)]. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x (${}_xq_0$) is related linearly to the logit of a standard probability of dying by age x (${}_xq_0^s$) so that

$$\text{logit } ({}_xq_0) = \alpha + \beta \, [\text{logit } ({}_xq_0^s)],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of marital fertility observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a cohort subject to a given set of age-specific fertility rates, a given set of age-specific mortality rates, and a given sex ratio at birth. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the reverse-survival procedure for fertility estimation, whereby estimates of age-specific fertility rates for the recent past are obtained by relating mothers to their own children, using information on relationship and other characteristics available from a census or survey.

PARITY See children ever born.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See partial birth rate.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage cohorts; see also cohort fertility.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived (${}_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, ${}_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

Reports and Workshop Proceedings of the Committee on Population and Demography

Report No. 1	*Estimation of Recent Trends in Fertility and Mortality in the Republic of Korea (1980)*
Report No. 2	*Fertility and Mortality Changes in Thailand, 1950-1975 (1980)*
Report No. 3	*Fertility and Mortality Changes in Honduras, 1950-1974 (1980)*
Report No. 4	*Age Misreporting and Age-Selective Underenumeration: Sources, Patterns, and Consequences for Demographic Analysis (1981)*
Report No. 5	*Estimation of Recent Trends in Fertility and Mortality in Bangladesh (1981)*
Report No. 6	*Collecting Data for the Estimation of Fertility and Mortality (1981)*
Report No. 7	*Data Collection: A Statement for Administrators (1981)*
Report No. 8	*Trends in Fertility and Mortality in Turkey, 1935-1975 (1982)*
Report No. 9	*The Estimation of Recent Trends in Fertility and Mortality in Egypt (1982)*
Report No. 10	*Indirect Techniques for Demographic Estimation (1981)**
Report No. 11	*Computer Programs for Demographic Estimation: A User's Guide (1981)*
Research on the Population of China: Proceedings of a Workshop (1981)	
Report No. 12	*Levels and Recent Trends in Fertility and Mortality in Colombia (1982)*
Report No. 13	*Fertility in Thailand: Trends, Differentials, and Proximate Determinants (1982)*
Report No. 14	*The Determinants of Fertility in the Republic of Korea (1982)*
Report No. 15	*Determinants of Fertility in Developing Countries: A Summary of Knowledge (1983)***
Report No. 16	*Determinants of Fertility in Developing Countries: An Overview and Research Agenda (1982)***
Report No. 17	*Socioeconomic Determinants of Fertility Behavior in Developing Nations: Theory and Initial Results (1982)*
Report No. 18	*An Exploratory Study of the 'Synthesis Framework' of Fertility Determination With World Fertility Survey Data (1982)****
Report No. 19	*Statistics in Fertility Research: Value and Limitations (1983)*
Report No. 20.	*Fertility Decline in Indonesia: Analysis and Interpretation (1983)*
Report No. 21	*Levels and Recent Trends in Fertility and Mortality in Brazil (1983)*

---

*Being published as manual X in the series of manuals of demographic analysis of the Population Division, Department of International Economic and Socal Affairs. United Nations (1982).

**Limited edition; being published by Academic Press, Inc. as part of *Determinants of Fertility in Developing Countries: A Summary of Knowledge.* © 1983 Academic Press, Inc.

***Published by World Fertility Survey, *Scientific Reports,* No. 40 November 1982.

Errata page iii

The list should include:

Hania Zlotnik, Research Associate